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ON THE ARTIFICIAL PRODUCTION OF STUPIDITY IN SCHOOLS.

IT is related of a learned judge, that he once praised a retiring witness in the following words: "You are entitled to great credit, sir. You must have taken infinite pains with yourself. No man could naturally be so stupid."

We cite this well-worn anecdote because it contains, probably, the earliest public recognition of the principle which the title of our article is intended to convey. Existing in all ages of the world, in all conditions of life, and described by a copious vocabulary in every language, stupidity is something which it has never been possible to ignore or to forget. The fact of its all-pervading presence, its vitality in the most different climates and scenes, has tended to convince mankind of the necessity of an evil which they have never failed to perceive; and which has served, from time immemorial, as a subject for the lamentation of the wise, and a basis for the calculations of the designing. The lessons of proverbial wisdom, the results of hasty generalization, and the daily experiences of life, all point out, or seem to point out, that stupidity is inseparable from the existence of the human race; and that it must appear, not in every individual, but in many individuals of every community. It follows that the persons in whom the phenomenon is most conspicuously manifested are regarded with something of the compassion which attaches to physical infirmity; and enjoy, in a certain degree, the power of blundering, with the privilege of being exempt from punishment.

We have long entertained a conviction that this passive acquiescence in stupidity, as an ultimate fact of human nature, and this confident expectation of its unmitigated recurrence in each succeeding generation, are founded upon errors of considerable practical importance. By directing attention to causes that are remote, they induce

forgetfulness of those which lie at every man's door; and, by bringing into prominence the stupidity which is irremediable, they lead us to neglect examination of that which may be prevented.

In truth, the varieties of hebetude are numerous. It must be admitted that some of them are displayed by persons whose intellects are obscured by organic defect, "native and to the manner born," in the nervous apparatus—by continuing deficiency, or excess, in the composition or quantity of the circulating fluid; and it is probable that, in many cases of this nature, the scalpel, or the microscope and test-tube, would fail to disclose the cause of the infirmity. Inherited diathesis, or hereditary disease, may doubless weaken the faculties of the mind, as they evidently weaken the physical powers of the body, and may produce effects varying in degree from idiocy to mere dulness of apprehension. We are far from saying that in these instances stupidity can neither be alleviated by judicious, nor confirmed by improper treatment; but we indicate them as affording a substratum of truth to popular prejudices touching the general invincibility of the state in question, and as giving evidence of its centric rather than eccentric origin.

But leaving this subdivision of the stupid entirely out of consideration, and remarking, by-the-way, that the word stupidity is misapplied when used to denote the mere absence of brilliant talent, we would call attention to the large class of persons who are dull and obtuse, not by reason of any probable congenital deficiency, nor by an unfair comparison with great wits or geniuses, but by comparison with what the individuals themselves clearly ought to be—with what they would have been had their faculties been developed in the right way. And this comparison is not so difficult as it may appear; for the simple reason that the human capabilities do not greatly depart, save in exceptional cases, from the standard of mediocrity. Among a score of men taken at random, but approaching to equality in point of conformation, we may observe that physical strength or endurance will vary only within very narrow limits: there being perhaps a single athlete, or a single weakling, and a remainder composed of individuals whose powers are not precisely on a level, but nearly so.

Let us suppose, however, that among the twenty men there were a certain number who had been employed from their early years in pursuits calculated to produce muscular vigor and hardihood, and who had observed all rules and precautions likely to insure to such pursuits their most favorable effects. It is certain that, whatever differences might exist among themselves, these men would surpass all their competitors. Bendigo, the champion of the prize-ring, was one of a triple birth, and was the weakliest child of the family in which, by reason of diligent training, he became the strongest man.

So universally has this principle been recognized and acted upon, that in every barbarous or half-civilized community, or under all cir-

cumstances which give an unquestioned superiority to bodily strength, we may find evidences of special care to foster and increase it. The "games" obligatory upon the little Spartans, the exercises of "gentle youth" during the age of chivalry, the description given by Mr. Catlin of the early training of the American aborigines, are all instances in point; and all show the recognition, under circumstances widely dissimilar, of the principle that the powers of the human organism are bestowed only in possibility—to be developed by culture, or to dwindle under neglect.

The state of physiological knowledge permits us to lay it down as an axiom that what is true of one system or apparatus, among those given to man, must also be true, *mutatis mutandis* (the necessary changes being made), of the rest. Without in the least degree failing to perceive the dependence of the higher faculties upon a spiritual nature, we must also perceive their dependence, during this life, upon the qualities of their material organs, the nervous centres; and the dependence of these qualities upon the laws which regulate nutrition and cell-growth. We are therefore entitled to assume, *a priori*, that, precisely as the methods of the trainer raise the physical powers of his disciples to the highest point attainable by each organism, so analogous methods would raise the intellectual powers in the same manner and degree. The conclusion which may be formed by reasoning is not unsupported by experience; but the masters of the art are few, and the examples of their skill are rare.

In an age of bodily repose, with nearly all locomotion artificial, with money as the principal purveyor, it is not surprising that men are careless about their physical powers, and think them hardly worth the trouble which their full cultivation would entail. Under circumstances in which strength of arm and fleetness of foot have afforded the chief sources of security, or have opened the most direct paths to renown, there has never been an approach to indifference about the means by which these qualities might be attained. If physical education be now almost wholly neglected, it is because the utility of its results has been diminished by the progress of civilization.

But this age of bodily sloth and weakness is also, it must be remembered, an age of intellectual activity and strength. The wide diffusion of knowledge, the facilities for travel, and the application of philosophy to the comforts and conveniences of life, have increased a thousand-fold the value, to each possessor, and to the whole human race, of the perceptive and conceptive faculties of the mind. Every one who observes the facts within his sphere, and reflects upon them, may find the key to some, as yet, unopened door in the temple of Nature, or may excogitate results calculated to increase the happiness of man. The career that offers itself to the intellect surpasses immeasurably all that has ever been offered to the corporeal powers; and it might, therefore, reasonably be expected that intellectual

development would be the subject of the same foresight now, which the development of the corporeal powers was wont to call forth in former days. It might be expected (although strength and activity of limb are left to come of themselves, under the unaided influence of that playful restlessness of the young which provides against muscular atrophy) that the training of the higher faculties of the mind into due vigor and perfect symmetry would be carefully studied as a science, and diligently practised as an art. It might be expected that the mechanism of observation and of thought, the nature and order of the processes by which, chiefly, wealth, and power, and fame are to be acquired, would be the subjects of an attention corresponding to the degree in which wealth, and power, and fame are prized. It might be expected that every one—the poor man to the extent of his means, and the rich man to the extent of his knowledge—would seek to confirm and strengthen in his offspring the qualities by which the world is ruled.

That the endeavor would not be fruitless, we have abundant evidence. Reasoning from an analogy which cannot fail, we find that the human organism scarcely ever approaches, under the influence of casual impressions or spontaneous acts, to any thing like the full measure of its powers. The average athlete is but the corporeal perfection of the average man—a perfection the result of labor, and which the common games of youth or pursuits of manhood are insufficient to produce or to maintain. The most striking example upon record of the physical predominance of one class of men over all others with whom they came in contact, was furnished by the Roman legionaries, in the days of the Roman conquests. It may be explained by the system which trained each legionary like a gladiator; and it disappeared as that system was relaxed and abandoned. The citizens of Rome, as such, could possess no natural superiority over, and in some cases not even an equality with, the inhabitants of the countries they subdued; but the citizens of Rome were trained to the exercises and formed to the discipline of war. Their physical powers were improved to the utmost, and they were inured to every variety of labor, fatigue, and hardship. The world has not witnessed a school of mental education upon a method so excellent, or upon a scale so grand; but the proverbial sagacity of the Jesuits, and the proverbial erudition of the Benedictines, may be cited to show that the mind will respond, always in some degree, and often vigorously, to a stimulus greater than that which is supplied by the usual events of life. It has been well said that Nature throws forth her able men as a salmon does its spawn, but produces her great ones as a lioness does her cub—singly, and at rare intervals. Whenever the want of an able man is felt and acknowledged, it is almost invariably supplied from among a limited circle of lookers-on, one of whom will find in the occasion a means of at once discovering and developing capabilities formerly dormant.

The various persons whose duties have required them to undertake original investigations into the phenomena of physical science have nearly always exhibited a remarkable intellectual growth as one reward of their exertions. They have become more cautious, more sagacious, more diffident than before; and there is not the slightest reason to suppose that they were, in the majority of instances, men of exceptional natural powers. On the contrary, the parallel facts connected with the muscular system, and the remarkable uniformity with which the faculties of reflection and judgment expand and strengthen under proper use, may conjointly be taken to prove that the ordinary life of civilized Europe does not develop either body or mind in a degree at all commensurate with their capacities for action. The cricket-field and the boating-club produce a certain amount of vigor and hardihood; but their most ardent votaries would be exhausted by the pastimes of a savage, or by the daily drill and duty of a soldier of old Rome. From the universities, and from schools of the first order, issue many men unquestionably of high attainments, and some of great and cultivated parts; but the aggregate of both classes may be said to have a point of resemblance to Brummel's finished cravat, and to suggest that a large number of "failures" have been quietly conveyed down-stairs.

In schools of an inferior kind, the attainments of the pupils are less conspicuous; and the existing state of mental education may be summed up in the earnest and weighty words of Prof. Faraday, who declares that, "in physical matters, multitudes are ready to draw conclusions who have little or no power of judgment in the cases; that the same is true of other departments of knowledge; and that, generally, mankind is willing to leave the faculties which relate to judgment almost entirely uneducated, and their decisions at the mercy of ignorance, prepossessions, the passions, or even accident." The same authority says again, that "society, speaking generally, is not only ignorant as respects education of the judgment, but is also ignorant of its ignorance."

It must be conceded, we apprehend, that in the present day no man is called upon to undergo a course of severe physical training, or to exercise the muscular system to the acme of its powers. But it must also be conceded that there have been conditions of society which rendered such training the duty of every one, and in which it was enforced by a public opinion of the most rigid kind. We think that, in the times in which we live, the duty of mental cultivation is at least equally binding, and that its performance requires to be prompted by the same incentive.

For we are convinced that a very large proportion of the stupidity now existing in the world is the direct result of a variety of influences, educational and social, which operate to the prejudice of the growing brain, either by checking its development altogether, or by

unduly stimulating the sensorium at the expense of the intelligence. In the former case, general obtuseness is the result; and, in the latter subjugation of the reasoning powers to the sensations or emotions. We are entitled to think these conditions strictly artificial; and to look upon them as distortions, analogous, in some respects, to the physical distortions of Hindoo fakirism.

The educational influence which, more than any other, is concerned in producing them, appears to us to be due to confusion of thought on the subject of those very distinct realities called knowledge and wisdom. While the prevailing weaknesses of the human mind—those apparent to the philosopher, and those also which are manifest to the vulgar—are alike due to want of wisdom, the efforts of ordinary instructors and the general current of the events of life are chiefly valued as they appear calculated to impart knowledge. It is not surprising that such should be the case, a great impulse having been given to education in this country at a time when the operations of the mind were not sufficiently understood to allow of a just discrimination between them.

Moreover, learning was a thing apparent and undeniable, easily perceptible to many who were unable to fathom its depths; while wisdom could only be recognized by the kindred wise, or in a fruition not always directly traceable to its causes. Hence, and in a manner not difficult to comprehend, arose a general impression that the acquisition of knowledge was the principal, or even the only, means of gaining wisdom; and this impression was confirmed by experience of the fact that mental development is frequently coincident with efforts to learn. The exact relation between the two is not easy to define, even with all the aid afforded by recent advances in psychology; but, in former times, it was the opinion of the most advanced educationists, that a certain routine of teaching afforded the best discipline for the growing brain, and that this routine, when aided by good abilities, was certain to produce the highest attainable results—so that men of moderate or inferior performance, who had received "a good education," were considered to be the failures of Nature, and not of the preceptor. The hypothesis was most comfortable, serving to shift responsibility from tutors and professors, and to place it where it was borne without a murmur, while the necessary interval between the schools and life was sufficient to render obscure any possible connection between bad teaching and eventual stupidity.

During the universal prevalence of such principles as these, commenced a movement which was formerly described as "the march of intellect," but which was, more correctly, a march of schooling. Men of various calibre, and various degrees of learning, were cordially united in an attempt to elevate the masses by education. For this purpose they organized a scheme by which to pour forth knowledge like water, and, in carrying it into practice, they spared neither age

nor sex. Cheap publications explained every thing—in a manner to be comprehended by everybody. The fathers of England were taught (with diagrams) the philosophy of their daily duties; the mothers, of their household avocations. Even unhappy little children, struggling through the sands of school, were caught and engulfed by the advancing wave. The great and good promoters of the original measure were overwhelmed by the coöperation of innumerable amateurs, who expected to make learning universal, by addressing, to the untaught, condensed statements of scientific results, and who looked forward to a time when the intellectual vigor of the community would be gauged by the reports of the Society for the Confusion of Useless Knowledge, or by the sale of illustrated penny serials, as the material prosperity is at present by the quarterly returns of the Registrar-General. The idea seemed to be, that the diffusion of knowledge would act as a stimulant upon all minds of sufficient natural power, and would call forth their energies—would set them thinking, comparing, judging; and that the rest of mankind, those not vitalized by the potent influence, were to be regarded as unworthy of consideration in a philosophical sense, however formidable in point of numbers.

Notwithstanding the great and sudden illumination to which we have referred, there is no evidence of any remarkable advancement, any increase at all commensurate with the pains bestowed, in that cultivation of mind by which alone knowledge can be applied or rendered useful. The words (already quoted) of Prof. Faraday may be taken as conclusive that the reasoning faculties, in all classes of the community, are very imperfectly and insufficiently developed—imperfectly as compared with their natural capabilities—insufficiently when considered with reference to the extent and variety of information with which they are called upon to deal. We are compelled to seek for the causes of this deficiency in an educational system that makes no adequate provision for mental training; and we think that a brief review of the relations between the nervous centres and the impressions that form the basis of knowledge will enable us to point out the precise nature of the chief errors in existing practice, and to define the principles by adherence to which those errors might be obviated.

The first point to which we would call attention is the existence, in the young of the human species, of a distinctly *duplex* educability, depending upon distinct functions of the brain. It may be taken as conceded, we apprehend, by all physiologists, that the encephalon of man differs from that of other mammalia chiefly by the super-addition of parts whose office it is to control the succession of ideas, and to determine the course of conduct. The powers of *re-collection*, comparison, reflection, and volition, are attributes essentially human, or, at least, are possessed by men in common with higher intelligences alone. The powers of sensation, ideation, and spontaneous remembrance, are

possessed also by the lower animals, and are sufficient to explain all the particulars of their conduct.

It is manifest, therefore, that the education of a child may be conducted, in the direction, and to the extent, in which it is possible to educate a horse, a dog, or an elephant, without necessarily trenching upon or at all arousing any faculty that is distinctly human in its nature. The child, moreover, possesses an endowment, of a purely sensational or animal kind, in which brutes are deficient, namely, the power (subsidiary to the gift of language) to remember a great number of sounds, and to imitate them with facility; so that, just to the extent of this power, the *sensational educability* of the human race exceeds that of the lower animals.

It should be remembered, moreover, that the functional activity of the sensorial tract of the encephalon is an absolute necessity of animal existence; and that, in men and brutes alike, it is provided for by an energetic tendency to spontaneous development under the influence of its appropriate excitants. In what may be termed the natural life, a blind submission to the promptings of sensations, present or remembered, would in all ordinary cases supply the wants, or gratify the passions of man. It is only in life modified by human aggregation that these promptings require to be controlled by an exercise of will, guided by a prior exercise of judgment; and, therefore, while Divine Providence has endowed the human race with sensational faculties that are called into vigorous action by daily wants or by physical impressions from without, we may observe that the higher powers of the mind, in a great majority of instances, cannot be matured excepting by assiduous cultivation.

In this respect, however, there is probably a considerable original diversity between individuals; and we are much inclined to think that herein consists the chief cause of gradations of ability among persons who neither greatly surpass an average standard nor fall greatly short of it. Observation teaches that it is far more easy in some children than in others to carry instruction beyond the sense-perceptions, and to call the intellect into activity; but, it teaches, also, that the supposed difficulty often arises from an improper selection or application of the means employed, and is simply a failure to open a lock with a wrong key. The apparently dull child not unfrequently receives the necessary stimulus from a trivial circumstance, from a conversation, a book, or a pursuit, and may grow into a gifted man; while a parallel transformation may be accomplished much later in life, under the influence of some new opportunity for action. It is possible that, in minds of the highest order, the intellectual faculties may possess the character of spontaneity which is commonly limited to the sensorial tract; but, in all ordinary cases, these faculties require to be excited in the pupil by their presence and their activity in the teacher.

The sensational and intellectual functions of the human brain are

not only distinct, but also in some degree antagonistic, through the application of the ordinary law of nutrition to their respective organs. The portions of the encephalon that are most employed will receive the largest supply of blood, and will be the seats of the most vigorous cell-growth, precisely as the same rule will apply to the development of muscle; while, on the other hand, a certain duration of disuse, or of restricted use, will occasion atrophic changes, and will be followed by that functional impairment which is a natural result of structural degeneration. It follows that men of the highest intellectual activity are often somewhat inattentive to impressions made upon their senses; and also that great sensational acuteness is often purchased at the cost of some torpor as regards the operations of the judgment.

Upon testing the educational customs of the present day by even the most elementary principles of psychology, it becomes apparent that a very large number of children receive precisely the kind of training which has been bestowed upon a learned pig. There are scarcely any teachers who have in the least degree studied the operations or the development of the mind (indeed, it is only within a very few years that this study has borne any fruit of great practical utility), and those who have not done so cannot realize the existence of a kind of learning which is sensational alone. Indeed, it is more in accordance with ordinary preconceptions to refer brute actions to a process of reasoning, than to consider that any human actions are automatic. The truth is, however, that the first impressions made upon the consciousness of a child have a strong natural tendency to expend themselves through the sensorium; and usually do so, unless directed higher by the manner in which they are produced or maintained. For the purpose of such direction, time is an element of the first importance, and the idea which would be grasped by the intelligence after a certain period of undisturbed attention, will excite the sensational faculties alone if that attention be diverted by the premature intrusion of something else that solicits notice. And while in almost every child the power of intelligent attention may be aroused by care, and perfected by perseverance, the natural inclination is toward a rapid succession of thoughts, variously associated, and remembered in their order without being understood. The faculty of comprehension, like all others, is a source of pleasure to the possessor, even in the first feeble attempts to bring it into exercise; and hence, as well as from the impulse given to nutrition, when once a habit of endeavoring to comprehend has been formed, although in very young children, it is not readily relinquished, but, on the contrary, is applied to the most unpromising materials.

In schools, however, under the stern pressure of the popular demand for knowledge, it is an extremely common practice to accumulate new impressions with greater rapidity than they can be received even by children who have enjoyed the inestimable advantage of early

domestic training toward the right employment of their higher faculties. The work laid down can often only be accomplished by means of the promptitude that is a chief characteristic of instinctive action. The child who uses his sensorium to master the sounds of his task, uses an instrument perfected for him by the Great Artificer. The child who uses his intelligence must perfect the instrument for himself, must grope in the dark, must puzzle, must catch at stray gleams of light, before his mind can embrace the whole of any but the simplest question. The former brings out his result, such as it is, immediately; the latter, by slow degrees; often first giving utterance to the steps by which he is reaching it. The former is commonly thought quick and clever; the latter, slow and stupid: and the educational treatment of each is based upon this assumption, widely as it is often at variance with the facts. The child whose tendency is to sensational activity should be held back, and be made to master the meaning of every thing he is allowed to learn. He is usually encouraged to remember sounds, is pushed forward, is crammed with words to the exclusion of knowledge, and is taught to consider himself a prodigy of youthful talent. The child who tries to understand his lessons should be encouraged, praised, supplied with food for thought of a kind suited to his capacity, and aided by a helping hand over the chief difficulties in his path. He is usually snubbed as a dunce, punished for his slowness, forced into sensational learning as his only escape from disgrace. The master, in many cases, has little option in the matter. Children are expected to know more than they have time to learn; parents and examiners must have show and surface, things only to be purchased at the expense of solidity and strength. A discreet teacher may often feel sympathy with the difficulties of a pupil; but the half-hour allotted to the class is passing away, the next subject is treading upon the heels of the present one, the child must complete his task like the rest, and so a budding intellect may be sacrificed to the demands of custom.

Among the children of the educated classes, the circumstances of domestic life usually afford to the intelligence an amount of stimulus which, if not of the best possible kind, is at least sufficient to compensate, in some degree, for the sensational work of school. The easy nursery-lessons of the prescholastic age, the story-books of childhood, the talk of parents and friends, all furnish food for leisurely reflection, all serve to suggest those strange questions that are one chief evidence of thoughtfulness in the young. Minds thus prepared may often flourish in spite of subsequent excessive teaching; and, by forgetting nine-tenths of what has been learned, may find it possible to understand the rest.

In what are called "elementary schools," however, those aided by the nation for the instruction of the children of the poor, we do not find this accidental provision against the paralyzing effects of the prescribed routine. For the most part, the children have grown up like

wild animals, excepting for the advantage of an occasional beating, and their nervous centres have received few impressions unconnected with the simplest wants of existence. Coincidently with an entire absence of intellectual cultivation, they usually display a degree of sensational acuteness not often found in the nurseries of the wealthy, and arising from that habitual shifting for themselves in small matters which is forced upon them by the absence of the tender and refined affection that loves to anticipate the wants of infancy. They go to school for a brief period, and the master strives to cram them with as much knowledge as possible. They learn easily, but *they learn only sounds*, and seldom know that it is possible to learn any thing more. In many cottages there are children who, as they phrase it, "repeat a piece" at the half-yearly examination. We say, from frequent experiments, that they will learn for this purpose a passage in any foreign language as easily as in English; or, that they will learn an English paragraph backward way, if told to do so; and that, in neither case, will any curiosity be excited about the meaning of the composition. In ordinary practice, the master explains what they repeat, saying this means so-and-so; and the pupils have sufficient sensational acuteness to remember the sounds he utters, and to reproduce them when called upon. They do not usually understand what "meaning" is. An urchin may be able to say correctly that a word pointed out to him is an adverb or a pronoun, may proceed to give a definition of either, and examples of instances of its occurrence, and may produce an impression that he understands all this, when the truth is that he has only learned to make certain noises in a particular order, and when he is unable to say any thing intelligible about the matter in language of his own. Or he may repeat the multiplication-table, and even work by it, saying that $7 \times 8 = 56$, without knowing what 56 is or what 7 times 8 means. He knows all about 7 or 8, not from schooling, but from the lessons of life, from having had 7 nuts or 8 marbles; but of the 56 which is beyond his experience he knows *nothing*. The nature of the mental operations of such children is perhaps as little known to the teacher, to the vicar of the parish, or the kind ladies who take an interest in the school, as the nature of the mental operations of the inhabitants of Saturn. The adults distinctly understand a thing which they feel to be very easy, and do not know that any children *can* talk about it correctly without attaching an idea to their words. They often think the teaching satisfactory which enables the pupil to explain things in set phrases. They do not realize the possibility that the explanation may be as little understood as the statement which it explains—that it may be like the tortoise in the Hindoo myth, which supports the elephant, but which, requiring support itself, only removes the difficulty by a single step—that it may be a second unknown quantity balancing the first in the equation $x=y$. Such, however, instead of bare possibilities, are too frequently actual results. We have

already referred incidentally to a learned pig, and to the parallelism between its training and some kinds of human education. Persons familiar with the tricks taught to animals are aware that these may all be described as muscular actions performed each consecutively to its proper signal. On hearing the finger-nails of the master click together, the animal does something in obedience to the sensation; nods its head, or shakes its head, or stands erect, as the case may be. It has no idea that the nod is an affirmation, or the shake a negation, and probably has no thirst for knowledge about the matter, being content to play its part correctly, and to escape the whip. In the case of children, the medium of communication is different, and the kind of response is different; but the faculty in action is commonly the same. The words of the pig's master are mere by-play, intended to amuse the audience, and the signal is conveyed by other sounds. The words of the human teacher or examiner, his questions, for instance, are the signals to the child, each requiring its appropriate answer; but, like the signals to the pig, they are aural sensations, capable, as such, of producing muscular action through the medium of the sensorium alone. The responses of the child are in words—that is to say, in sounds that he has been taught, and that he remembers, but of which he need not understand one iota in order to repeat them, any more than the pig need understand the affirmative or negative character of its nod or shake. In the human species, articulate speech is an act precisely analogous to locomotion, requiring the combined and harmonious working of several muscles, and the guidance of sense, but in no way essentially connected with the intelligence; and the child may make the right noises in the right order, just as the pig does not nod its head when the signal requires it to be shaken.

A general idea of the facts, which we have endeavored to state, was conveyed to the public many years age by a phrase now almost forgotten. Educationists found, by experience, that children managed to retain sounds without meaning, and they called the process "learning by rote." Books, pamphlets, and speeches, bore witness to the practical inutility of such learning, and were full of suggestions for improving upon it. But these suggestions, to the best of our recollection of them, did not go to the root of the matter, and were mainly based on the assumption that learning by rote was characterized by some sort of deficiency only, and not by a radical error in the kind of impression made upon the pupil. It was not distinctly stated, or commonly conceded (although often implied in phraseology), that the action of the child's mind was of a nature essentially distinct from that which it would be the object of a wise instructor to excite; and the cause of the error was mainly sought in teaching not carried far enough to be beneficial, or not continued sufficiently long to produce permanent results. We conceive that the recent development of nervous physiology entitles us to maintain that learning by rote is at once

the effect and the evidence of operations limited to the sensorial ganglia; and that such operations have no tendency, however they may be complicated or prolonged, to excite those functions of the cerebrum which are the peculiar attributes of humanity.

Our brief remaining space must be devoted to an examination of the effects of sensational learning, both as it exists in most schools for the poor, and also in the form, more or less modified, which may be found in other institutions.

Physiologically speaking, the effect of purely sensational learning will be to stimulate the nutrition and increase the vigor of the sensorial tract at the expense of neighboring and related organs. As we have seen, the sensorium has a natural tendency to predominance in the encephalon; and this tendency will be increased in every way, absolutely by direct excitation, and relatively by neglect of the intellect and volition. The sensations by which the stimulus has been given will not be long remembered, being superseded by fresh ones arising out of events, as the apparatus of the gymnasium would be superseded by the instruments of actual conflict. With the exception of being, perhaps, able to read with labor, and to write with difficulty, the pupils must not be expected, six months after leaving school, to possess any traces of their "education" beyond an invigorated sensorium and a stunted intelligence.

Now, when it is remembered that present sensations are the source of the least exalted kinds of animal gratification, and that sensations, either present, or remembered, or conceived, when combined with a feeling of pleasure or pain, constitute the emotions which so powerfully influence human conduct, it must be admitted that the sensorium is at least the seat of development of those passions and propensities which society, for its own good, is compelled to keep in check, and which every consideration of right teaches individuals to subdue. When, therefore, we reflect upon the operation of predominant emotions in producing, among other evils, chorea, hysteria, epilepsy, and insanity, or when we consider the aggregate of misery produced, especially among the lower orders, by the unbridled indulgence of various appetites, we cannot altogether concur in the propriety of a system of education which has a direct tendency to raise the source of these emotions and appetites to an undue and unnatural prominence in the organism. In our own experience we have met with so many examples of what may be called habitual non-reflection in young people who had been six months before among the most glib and fluent pupils at a sensational school, that we fancy that we can recognize a kind of stupidity thus induced, and that we can readily distinguish it from any thing at all similar that is purely natural.

We should be disposed, on the whole, to seek the *rationale* of many educational failures rather in a partial and misdirected training of the intelligence, than in its complete suppression. The pupils

mix intellectual and sensational acts, not in their proper relations with each other, but in a jumble. Comprehension is brought to bear upon every thing that is easy; while a difficulty of any kind is committed to the safe keeping of the sense perceptions, and the explanation of it is only remembered. Hence arise a habit of resting upon imperfect knowledge, and a habit of loading the memory by the aid of faulty associations; and these habits, in their turn, are the sources of the lively superficial stupidity which is so common among the better classes. The sufferers from it form that great public to whom are addressed the Morisonian system of pathology and therapeutics, and the elaborately argued advertisements of Norton's Camomile Pills. Every thing that follows "because" is to their minds an explanation; every thing that has an antecedent is to their minds an effect. Their creed is, that all questions lie in a nutshell; and, according to Prof. Faraday, their shibboleth is "it stands to reason." On this ground they would placidly maintain against Owen the existence of the sea-serpent. For their especial behoof bubble companies are formed; and upon their weaknesses innumerable imposters thrive. Their deficiency is chiefly this—that, having been permitted from childhood to do many things superficially and with inexactness, they have forfeited the power of arranging their ideas with precision, or of comparing them with caution. They can therefore scarcely be said to possess any assured convictions, or rooted principles of conduct; but, nevertheless, they are ready to decide in all controversies; and are "wiser in their own conceit than seven men who can render a reason."

The cause of such educational errors we should express in the single word—empiricism. For successive ages teachers had no guide but experience; and the results of this experience appeared to defy generalization. The almost self-evident proposition, that the training of the mind should be guided by an analysis of its powers, was brought into early disrepute by the conditions under which such analysis was attempted. The men engaged in it, learned, patient, laborious, profound, reached the limit of discovery by the method of reflection long before the method of observation was disclosed to them. Too exclusively metaphysical, they wanted a link to connect them with the material world. Like the children of Israel, they were wandering in a wilderness before they entered the promised land. Their advanced messengers had not yet returned, bringing of the fruits that were hereafter to reward their labor. Foiled in their advance by a barrier that seemed impassable, they were tempted to waste their energies in the invention of technicalities and the multiplying of verbal distinctions. Under such circumstances the science and its professors were too broad a mark to escape the shafts of satire; and thus, even at the present day, there are scars to show the wounds which those shafts have made.

During the last few years, however, the dark portions of this much-

contemned pursuit have received unexpected illumination from the study of the nervous centres. The painstaking researches of Bell, Marshall Hall, and less conspicuous fellow-laborers, endowed with value and stamped with currency by the lofty generalizations of the living philosopher who has so long been *facile princeps* (the admitted chief) among all inquirers into the functions of the nervous system, have already produced a psychology that is available for practical purposes, and that promises to increase daily in importance. In the mean while education has spread enormously, but educators persist in traversing the broad old road. The larger the field for their efforts, the more conspicuous becomes the poverty of their results. At one time, learning by rote was the great obstacle; and they attacked, as the last difficulty in their path, what was but the first aspect of a Proteus. At present (with the scheme of national education all but a confessed and palpable failure; with numerous individuals in all ranks displaying powers developed late in life by circumstances, but never suspected before; and with a waste of the national intellect that may possibly be equivalent to the daily loss of a century's progress), the office of preceptor is still confided to persons who have never bestowed a single thought upon the faculties, or the mechanism of the mind, and who cannot distinguish between sensational and intellectual action, if the former be veiled by the smallest complexity.

Toward the carrying out of any improvement in education, the first step must be to demand from teachers, either a knowledge of mental philosophy, or, at least, of a scholastic art founded upon the principles which mental philosophy would inculcate. We believe this demand must inevitably be made in process of time; but we feel also that it would be greatly promoted if the medical profession would recognize, and strive to impress, the distinct bearing of physiology upon the development of the mind, as well as upon that of the body.

The practical difficulties, which it is easy to foresee, all resolve themselves, pretty clearly, into one. An inquiry after intelligent and intelligible teaching has not yet issued from the public. They are content with something else. Whenever this contentment ceases, the means of supply will spring out of the want. And, until then, we would urge upon individual parents that they may accomplish much by encouraging in their little ones a spirit of curiosity, and a habit of comprehension. Whether the fire of intellect shall blaze, or smoulder, will depend in many cases upon the manner in which it is kindled; and this kindling is among the things that can be done, most effectually, under the mild influences of home.—*London Journal of Psychological Medicine.*

THE SPOTS ON THE SUN.

By THE EDITOR.

SHALL the Eye of the Universe suffer from ophthalmia? Shall the orb of celestial fire in the incorruptible heavens—type of purity and perfection—noblest symbol of God—be stained and blackened with impurities? Such were the questions indignantly asked when it began to be whispered about that there are spots of darkness on the face of the sun.

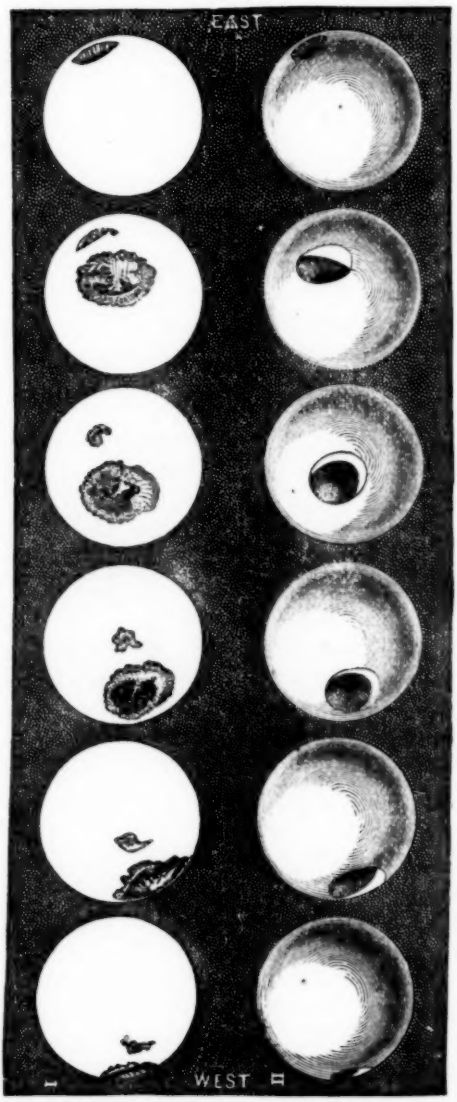
Yet again what was thought impious and impossible proved true: and again it was demonstrated that the cherished opinions of thousands of years were not only erroneous, but were in flat contradiction to the truth. Not only were spots, which it was thought profane even to suspect, shown to be realities, but they have turned out to be the principal means of letting us into a knowledge—such knowledge as we have—of the solar constitution.

It is now upward of 250 years since the invention of the spy-glass led to the revelation of the solar spots, which has been variously attributed to Fabricius, Galileo, and Scheiner, the Jesuit astronomer. It is said of Scheiner, and it well illustrates the spirit of his age, that he dared not publish his discovery, and at first confided it to only a few of his most intimate pupils. After repeated observations that removed all doubt as to their existence, he consulted the provincial father of his order, who refused to believe in any thing of the kind; "For," said he, "has not Aristotle said that the sun is all over shining with light? I have several times," he sagely observed, "read my Aristotle all through from beginning to end, and I can assure you that he mentions not a syllable about it. Go, my son, make yourself easy, and take it for certain that what you suppose to be spots on the sun, are nothing but specks in your eyes or flaws in your glasses." Scheiner obeyed, admitting that his eyes must be in the wrong, and Aristotle in the right, for he lived in an age of credulous faith and blind authority. A doubting pupil of his, however, wrote to Galileo, who replied: "Scheiner's eyes are as good as need be; I have myself watched those spots for some time past."

Scheiner at first considered these dark specks to be minute planets travelling round the sun close to his surface, but Galileo more shrewdly concluded that they were part of the sun itself, perhaps floating scum or scoria, and he saw their importance in astronomy. For not only do they prove the revolution of the sun on its axis, but they afford the only means of ascertaining the time of that revolution, the position of the solar axis and its inclination to the earth's orbit. Galileo therefore watched the spots with an interest and assiduity so great that it finally cost him his eyesight.

When we look at the sun through clouds, or through a darkened glass, it appears as a uniform disk of light. But, when we look at it through a telescope of moderate magnifying power, the uniformity of

Fig. 1.



The Changes in the Appearance of a Spot, caused by the Rotation of the Sun.

surface disappears, and we see it irregularly sprinkled with dark points known as *solar spots*. These are, however, not always seen; sometimes the solar disk is perfectly clear. It has been found that for a period of ten years, from 1840 to 1850, out of a total number of 1,982

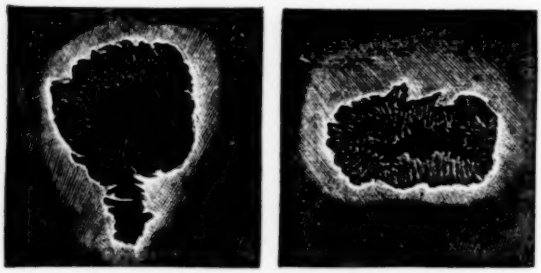
days when the sun was observed, there were only 372 days when spots were not seen.

The spots vary in size and number: sometimes but a single one appears, and as many as 80 have been visible at one time. Nor are they equally distributed over the solar surface. The region of the spots is generally confined to the part of the sun within about 30° of its equator, beyond which they are rarely seen.

The *photosphere* is the name given to the silver sea of light by which the spots are surrounded, and in which they seem to swim; it is the immediate source of illumination, and, viewed through a glass of low power, it appears flat and smooth, and of a uniform whiteness.

But, when a telescope of high magnifying power is directed to the sun, its aspect is greatly changed: the spots lose their simplicity, and the photosphere its uniformity, and in both there are a revelation of *structure*, a diversity of parts, and a variety of changes, which at once provoke questions in the mind of the observer, as to the causes of this diversified appearance, and the constitution of the body which presents

FIG. 2.



Solar Spots, showing Furrows in the Penumbra.

them. The hypotheses put forth are ingenious; but, while the facts of observation are rapidly increasing, and there is a growing agreement on many points, there is still profound uncertainty as to the interpretation to be given to the leading phenomena.

Spots upon the sun's surface have been frequently seen with the naked eye. Galileo saw one at sunrise. It was the observation of a solar spot with unassisted vision that so impressed Sir William Herschel as to determine his attention to the physical nature of the sun. The eminent observer Schwabe has also seen many without the aid of the telescope. Solar spots, therefore, are discernible without glasses at a distance of 91,000,000 of miles; but Lockyer says that the finest telescope enables us to see the sun as we should do with the naked eye at a distance of 186,000 miles, that is, 52,000 miles nearer than the moon. The sun is about 62,000,000 times larger than the moon, and Brande states that the smallest space that can be discovered in the sun's disk must subtend an angle of one second, which is equal to

about 460 miles. These facts give us some idea of the mighty scale of solar phenomena.

The solar spots have a general movement with the surface of the revolving sun, and they have also minor movements of displacement. They always make their first appearance on the same side of it; they travel across it in from twelve to fourteen days, and then disappear on the other side. The form of a spot in its first appearance is that of a small, dark streak, the length of which is much greater than the breadth. Its motion appears slow at first; it afterward increases, then slowly diminishes, until again assuming the form of a narrow streak. Fig. 1, from Dr. Schellen's finely-illustrated work on Spectrum Analysis (as are all the illustrations of the present article), represents this change of appearance of a spot as it emerges, passes across the field of view, and disappears. Of course, its relative size, as here shown, is enormously exaggerated.

The solar spot consists principally of a dark, almost black, central portion, generally irregular in form, called the *umbra*. Mr. Dawes has shown that, within this part of a spot, one or more still blacker spots may generally be observed, to which he gives the name of *nucleus*. The term *black*, however, as applied to an object on the sun, is to be taken with caution, and means merely a diminished intensity of solar light, which, by contrast, appears black. Zollner states that the black umbra of a spot emits four thousand times as much light as that derived from an equal area of the full moon; and Sir John Herschel says that the Drummond light, which is so bright that the eye can hardly endure it, when projected on the sun, appears as a black spot!

Surrounding the umbra is a tract less dark, usually more regular in form, and of a fringe-like aspect, called the *penumbra*. Its appearance is illustrated in Fig. 2, and is represented by the half-tints around the darker umbra in all the accompanying delineations. But, before we can understand the structure of the penumbra, it will be necessary to refer to what is known of the surrounding bright solar surface.

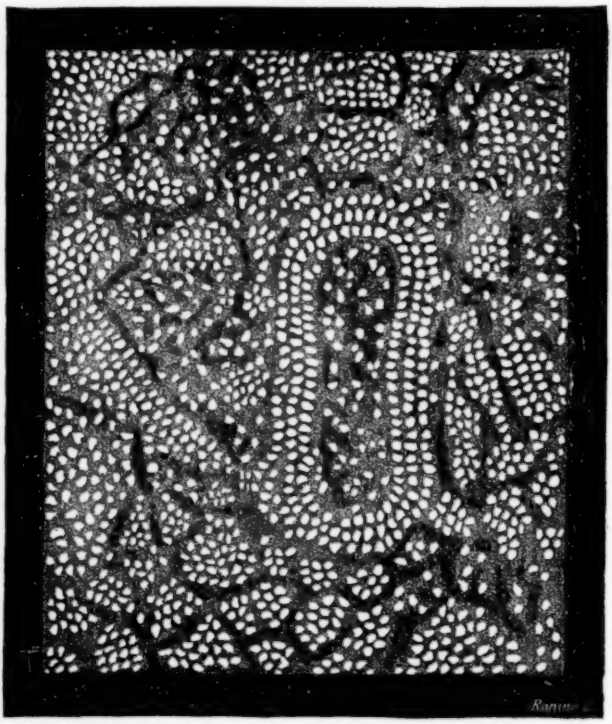
Viewed by a telescope of moderate power, the photosphere loses its uniform aspect, and exhibits a coarsely *mottled* appearance. But, if an instrument of the highest grade is used, the photosphere is seen to have a far more definite structure, and exhibits appearances which are variously described by different observers. Sir William Herschel calls these appearances "corrugations." They are small points of unequal light, imperfectly separated from each other by rows of minute dark spots called *pores;* the intervals between them being extremely small, and occupied by a substance decidedly less luminous than the general surface. Some call them "rice-grains;" Mr. Huggins names them "granules," and his representation of them is given in Fig. 3. The photosphere is again described as resembling a net of bright meshes interwoven with dark threads.

Certain portions of the photosphere are much brighter than others;

these are termed *faculæ*, and are, in fact, the opposites of the solar spots. They are devious, undulating, shining ridges, like irregular ranges of snowy mountains, and are represented as from 1,000 to 40,000 miles long, and from 1,000 to 4,000 miles in breadth. They are frequent near the sun's edge, and often accompany the coming and going of the spots. But they are generally the attendants of the spots, and often appear at points where spots are about to break out. Their bright, concentrated, tortuous appearance in the neighborhood of a spot is represented in Fig. 4.

Another remarkable appearance of the sun's surface consists of

FIG. 3.



"Granules," "Pores," or "Rice-Grains," shown upon the Sun's Surface, by the Telescope.

streaks or blades of light—the "slashed straws" of Dawes, or the "willow-leaves" of Nasmyth. These, says Sir John Herschel, cover the whole disk of the sun (except the spaces occupied by the spots) in countless millions, and lie crossing each other in every imaginable direction. Mr. Dawes denies that they are so general, but they are universally recognized in the vicinity of the solar spots, taking a radial direction around the penumbra, and giving it a jagged or coarsely-thatched appearance. Father Secchi says: "I would compare them to elongated masses of cotton of every possible form, sometimes en-

tangled with one another, sometimes neatly truncated, or again spread out with no distinct termination. Their head is generally turned toward the centre of the nucleus. They are not unlike strokes of color laid on with a painting-brush, very white near the head, and gradually less brilliant toward the tail." Fig. 5 represents a group of solar spots, in which this closely-meshed appearance of the ovoid bodies is impressively presented; and in Fig. 6 we see the willow-leaf structure stretching completely across the umbra and forming bridges of light.

The dimensions of solar spots are as variable as their forms. Some are very small, appearing under the highest magnifying power like mere specks; others are of enormous magnitude. Many have been observed which measure from 30,000 to 100,000 miles in diameter, so that, if they are truly chasms and gulfs in the luminous envelope of the sun, our entire globe, as Guillemin remarks, would appear in their depths no larger than a fragment of a rock rolled into the crater of a volcano!

The changes which these bodies undergo are extraordinary. They seem to have an order of development. Proctor says the formation of a spot is usually preceded by the appearance of faculæ. Then a dark point makes its appearance, which increases in size, the penumbral fringe being presently recognized around it, and the distinction between the umbra and the penumbra being well defined. But, when the spot is about to diminish, the edges lose their sharpness as if screened by a luminous veil; capes and promontories jut out, and bridges of light are formed. Lockyer says sometimes changes are noticed even within an hour. Their periods are most variable; the smallest merely appear and disappear, lasting a mere fraction of the time of solar rotation. The larger live frequently during two rotations, and Schwabe saw one which returned eight times, continuing 200 days.

The remarkable changes that sometimes occur are well illustrated in Fig. 7, which represents four drawings of the large spot that appeared October 7, 1865, and which was more than 46,000 square miles in area. The drawings are numbered in the order of date. No. 1 exhibits the oblong, fore-shortened view presented when it first appeared on the edge of the sun. No. 2 represents its aspect three days afterward. No. 3 shows its appearance four days later, and No. 4 is a view of it on October 16th.

Sometimes spots exhibit a rotatory or whirlpool appearance, as if the solar envelope were subject to tremendous tornadoes. Fig. 8 represents a spot seen and drawn by Secchi at Rome, May 5, 1857, which represents a vortex, into which the substance of the photosphere is rushing with an eddying motion. De La Rue took two photographic pictures of the same spot at an interval of two days, and, when these are placed together and looked at through the stereoscope, the spot exhibits a funnel-like concavity with remarkable exactness. There is other evi-

dence that the sun-spots are of the nature of depressions or openings in the photosphere. Both Herschels claim to have observed a notch in the sun's edge as a spot is disappearing; and the order in which the parts of a spot appear and disappear at the solar border is not what it would be if the spot were *even with the surface*, but is just what it would be if it were a rent or opening.

The question before us is one of solar meteorology. Spectrum analysis proves that matter exists upon the sun in a gaseous form. The great mobility of its envelope, and the rapidity and extent of its changes, imply an atmosphere of extreme complexity, and probably of great depth. The appearances of the solar atmosphere are believed to

FIG. 4.

Faculæ in the Neighborhood of a Spot.—(Chacornac.)

be due to masses of the nature of clouds. But, while our clouds are watery, or are formed by precipitated aqueous vapor, the solar clouds are inferred to be more or less metallic, or to be composed of particles of various metals and other substances in a state of intense heat. Metallic vapors, at any rate, are proved to exist on the surface of the sun.

The first hypothesis of the solar constitution, which professed to account for the spots, was put forth in the last century by a Scotch astronomer, Alexander Wilson, and was accepted with modifications by Bode and Herschel, and continued to prevail until within a few years, being accepted by Arago. It was formed under the old *anthropocentric* bias; that is, the notion that man is the central object of

the universe, which has been built around him and for him, and with reference to him as the supreme object. This led to the belief in the inhabitability of worlds; for, if stars and planets were not for man to live on, what can they be good for! And, hence, solar theories were so framed that it might be possible to conceive of the sun as the dwelling-place of man. The nucleus or body of the sun was assumed to be opaque and solid, or, at all events, that it had a solid shell corresponding to the earth's crust. Surrounding the spherical nucleus at a certain distance above it, there was supposed to be a first atmosphere which may be compared to the earth's atmosphere when the latter is occupied by a continuous layer of opaque, reflecting clouds. Above this first layer, and more or less distant from it, there was held to be a second atmosphere which is luminous, and answers to the photosphere, or the visible periphery of the solar orb.

On this view a solar spot results from a rent in the atmospheric layers, by which the dark nucleus becomes visible, forming the umbra. The rupture of the two atmospheres, it was supposed, might be caused by volcanic action, or by "gaseous matter formed from time to time at the surface of the dark nucleus, the high temperature of which causes its deflagration." Again it was said: "It may happen that the opening is wider in the cloudy atmosphere than in the luminous envelope or photosphere, in which case the dark nucleus alone would be seen, and we should have a spot without a penumbra. Or the rupture of the first gray envelope becoming closed before that of the photosphere, would have for effect to shut out the view of the dark globe, and we should have a penumbra without a nucleus."

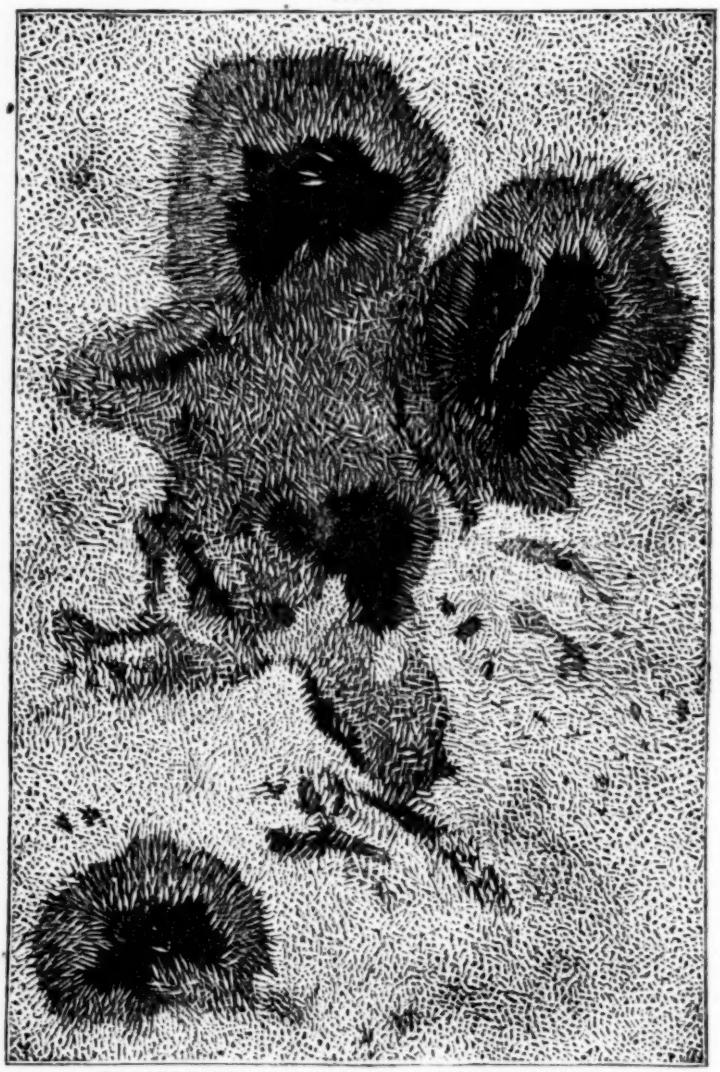
The later tendency is to abandon the notion of a dark nucleus. Indeed, the explanations of the spots now most in favor recall that of Galileo: he suggested a floating scum, while all the late physicists hold that the spots are due to the agency of precipitated clouds.

Kirchhoff, whose honor it is to have first applied spectrum analysis to the study of the sun, and discovered its chemical elements, maintains that the visible portion of the sun, the surface which constitutes the photosphere, is a solid or liquid sphere in a state of incandescence. Its temperature is very high, and it is surrounded by a dense atmosphere formed of the elements which constitute the incandescent globe itself, whose extremely high temperature maintains them in a state of vapor or gas. The lines of the solar spectrum, instead of being bright and variously colored, are dark, which proves that the light has passed through a medium of absorption. Kirchhoff's view is, that the light emanates from the solid or liquid photosphere, and is filtered of its colors or has its lines reversed in passing through the sun's atmosphere.

He explains the spots by supposing that, from some unknown cause, certain parts of the sun's surface undergo a temporary cooling, by which clouds are condensed above that intercept the rays and then ap

pear as an opaque layer—the umbras of spots. A cloud once formed in this manner acts as a screen toward the higher regions; hence a secondary cooling effect in those regions also, and the formation of another cloudy layer, less dense—the penumbra.

FIG. 5.



Group of Solar Spots observed and drawn by Nasmyth, June 5, 1864.

The speculations of M. Faye upon this subject have also attracted some attention. He assumes the sun to be still in a gaseous state. The photosphere he regards as consisting of clouds which are the simple consequence of cooling, and looks upon it, in fact, as the limit which

separates the intense heat of the interior portions of the sun from the cold surrounding space. He holds to powerful ascending and descending currents, which result here and there in breaks and dispersions by which openings are made to the gaseous interior, giving the appearance of spots; to which Kirchhoff replies that an incandescent interior, at so high a temperature, would certainly be luminous.

In 1858, before the views of either Kirchhoff or Faye were announced, or spectrum analysis had been applied to the subject, Mr. Herbert Spencer published an article on "Recent Astronomy and the Nebular Hypothesis," in which he anticipated some of the most important results that have been arrived at since by others. He took the ground that the sun is still passing through that incandescent stage which all the planets have long ago passed through, the lateness of his cooling being due to the immensely greater ratio of his mass to his surface. He supposes the sun to have now reached the state of a molten shell with a gaseous nucleus; and that this shell is ever radiating its heat, but is sustained at its high temperature by the progressive condensation of the sun's total mass.

As respects the solar atmosphere, Mr. Spencer said in 1858:

"If we consider what must have been the state of things here when the surface of the earth was molten, we shall see that, round the still molten surface of the sun, there probably exists a stratum of dense aëriform matter, made up of sublimed metals and metallic compounds, and above this a stratum of comparative rare medium analogous to air. What now will happen with these two strata? Did they both consist of permanent gases, they could not remain separate: according to a well-known law, they would eventually form a homogeneous mixture. But this will by no means happen when the lower stratum consists of matters that are gaseous only at excessively high temperatures. Given off from a molten surface, ascending, expanding, and cooling, these will presently reach a limit of elevation above which they cannot exist as vapor, but must condense and precipitate. Meanwhile, the upper stratum, habitually charged with its quantum of these denser matters, as our air with its quantum of water, and ready to deposit them on any depression of temperature, must be habitually unable to take up any more of the lower stratum; and therefore this lower stratum will remain quite distinct from it. We conclude, then, that there will be two concentric atmospheres, having a definite limit or separation."

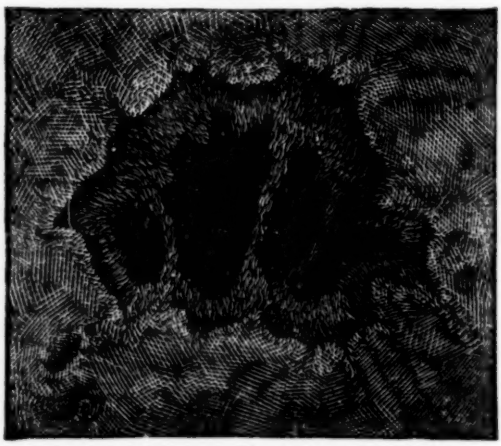
This view was sustained in the most remarkable manner, by the subsequent discoveries, through spectrum analysis, of the metals iron, calcium, magnesium, sodium, chromium, and nickel, in a gaseous state in the atmosphere of the sun.

As respects the solar spots, in the article above quoted, Mr. Spencer suggested that they were due to cyclonic action. He has subsequently developed this view, which is now regarded as the most rational explanation we have of the cause of solar spots. In the latest edition of "The Heavens," by Guillemin, published last year, translated by Lockyer, and edited by Proctor, after a review of the subject, and an examination of all the theories that have been pro-

posed, the view of Mr. Spencer is presented last, as more in conformity to the facts than any other. After showing how the hypothesis of M. Faye is discredited by the spectroscopic observations of Lockyer, Huggins, and Secchi, they say: "It follows conclusively that the spots are regions of increased absorption. This accords with Mr. Herbert Spencer's theory, with which also the observations of Mr. De La Rue and Dr. Balfour Stewart are in satisfactory agreement. Let us now," say they, "present the theory of Mr. Spencer, whose suggestions as to the possible causes of solar spots are very valuable.

"Mr. Spencer, basing his reasoning on terrestrial analogies, thus accounts for the spots: 'The central region of a cyclone must be a region of rarefaction, and consequently a region of refrigeration. In an atmosphere of metallic gases rising from a molten surface, and reaching a limit at which condensation takes place, the molecular

FIG. 6.



Solar Spot, with Three Bridges of Light.—(Nasmyth.)

state, especially toward its upper part, must be such that a moderate diminution of density and fall of temperature will cause precipitation; that is to say, the rarefied interior of a solar cyclone will be filled with cloud; condensation, instead of taking place only at the level of the photosphere, *will here extend to a great depth below it.*' It will be seen that Mr. Spencer, as opposed to Kirchhoff, not only accounts for the formation of a cloud, but places it where the objections made to Kirchhoff's clouds do not hold good. He next shows that a cloud thus occupying the interior of a cyclone will have a rotary motion, and this accords with observation. Being funnel-shaped, as analogy warrants us in assuming, its central parts will be much deeper than its peripheral parts, and therefore more opaque. This, too, corresponds with observation. Nor are we, on this hypothesis, without some interpretation of the penumbræ. If we may suppose the so-called 'willow-

leaves'—the 'things' on the sun—to be the tops of the currents ascending from the sun's body, what changes of appearance are they likely to undergo in the neighborhood of a cyclone? For some distance round a cyclone there will be a drawing-in of the superficial gases toward the vortex. All the luminous spaces of more transparent clouds, forming the adjacent photosphere, will be changed in shape by these centripetal currents; they will be greatly elongated, and those peculiar aspects which the penumbra presents will so be produced."

Mr. Spencer, however, in his article in the former number of THE POPULAR SCIENCE MONTHLY, says that at present none of the interpretations of the solar spots can be regarded as established.

"All this is, no doubt, very curious, but it is very remote and unpractical. What have the solar spots to do with me, or I with the solar spots?" exclaims some impatient reader. But suppose it turns out that the spots on the sun do have a very close connection with earthly affairs—what then? The story of these strange appearances is incomplete till this point also is noticed.

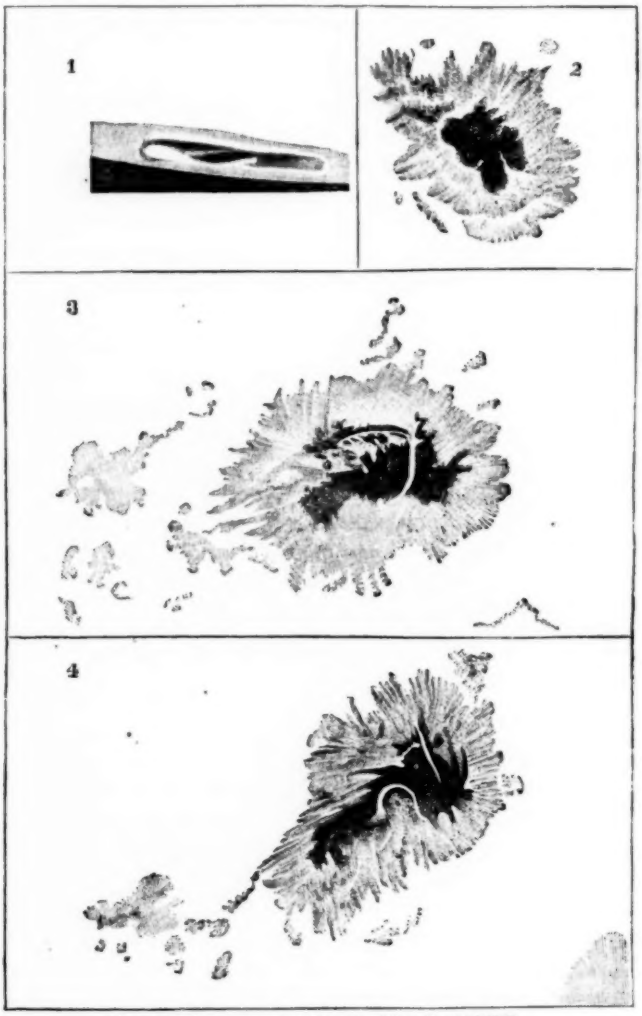
The view which connects the spots with cyclonic action is confirmed by the now demonstrated fact that they are mighty solar agitations, whose influence is felt in distant planets. Schwabe has discovered that the spots, instead of being uniform in number and intensity from year to year, have a periodicity increasing to a maximum, and then declining to a minimum in a course of years. The variations consisted in the number of days in the year in which spots were visible, and in the number of groups observed. The indomitable perseverance of this astronomer is something wonderful. The president of the English Astronomical Society, in awarding him its gold medal, said: "For thirty years, never has the sun exhibited his disk above the horizon of Dessau, without being confronted by Schwabe's imperturbable telescope, and that appears to have happened about 300 days in a year. So that, supposing he observed but once a day, he has made 9,000 observations, in the course of which he has discovered 4,700 groups." In these observations, he traced three complete oscillations from maximum frequency, through minimum back to maximum again. The period assigned by Schwabe was about ten years, although Prof. Wolf, of Zurich, has showed that 11.11 years (or the ninth part of a century) is indicated rather than a ten-yearly period.

It has been established that there is a coincidence between this sun-spot period and magnetic disturbances on the earth. In every part of the earth the magnetic needle has at any given time a certain definite position, about which, under normal conditions, it will oscillate during the day. Proctor says:

"Each day the needle oscillates gently about its position of rest, the oscillation corresponding to a very slight tendency, on the part of that end of the needle which lies nearest to the sun, to direct itself toward his place. The daily oscillation is itself variable in a systematic manner, not only with the progress

of the year, but with that of the lunar month. The daily oscillation also varies at times in a sudden and irregular manner. The needle has been exhibiting, for several weeks, the most perfect uniformity of oscillation. Day after day the careful observation of the needle's progress has revealed a steady swaying to and fro, such as may be seen in the masts of a stately ship at anchor on the scarce-heaving breast of the ocean. Suddenly a change is noted; irregular movements

FIG. 7.



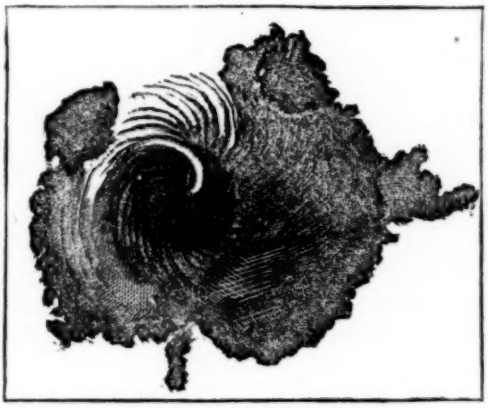
Changes of Appearance of the Great Sun-Spot of 1865.

become perceptible which are totally distinct from the regular periodic oscillations. A magnetic storm is in progress, and its progress does not affect only the place of observation, but widely-extended regions of the earth; and in some well-authenticated instances these magnetic vibrations thrill in one moment the whole frame of the earth."

Lamont, of Munich, in 1850, was the first to announce that these magnetic disturbances attain a maximum of frequency in about ten years. Two years later, Sabine, Wolf, and Gautier, noticed the coincidence of this period with that of the solar spots. And this coincidence was more than general. There was a coincidence of maximum spot-frequency with maximum of magnetic disturbance, and of minimum with minimum, which compelled them to assert a causal connection between the two periods. Wolf subsequently proved that the period of magnetic disturbance has the length of 11.11 years.

But there is still more striking evidence of this connection. On September 1, 1859, Mr. Carrington, an eminent English astronomer, happened to be intently engaged in observing and mapping a group of spots, when a sudden and most extraordinary outburst occurred, of so startling a nature that, having noted the exact moment by his chronometer, he hastily ran to call some one to see the exhibition with him;

FIG. 8.



Spiral Solar Spot, or Cyclone, observed by Secchi.

when upon returning, within 60 seconds, the whole spectacle had disappeared. "The spots had travelled considerably from their first position, and vanished as two rapidly-fading dots of white light. In the interval of five minutes, the two spots transvered a space of about 35,000 miles." He likens the appearance to that of a sudden conflagration. This was also independently seen at the same moment by Mr. Hodgson, who says: "I was suddenly surprised at the appearance of a very brilliant star of light, much brighter than the sun's surface, and most dazzling to the protected eye. It lasted some five minutes, and disappeared instantaneously."

At the moment when the sun was thus disturbed, the magnetic instruments at Kew exhibited the signs of great magnetic disturbance. "It was found," says Dr. Balfour Stewart, "that a magnetic storm had broken out at the very moment when this singular appearance had

been observed." Nor was this all. A magnetic storm never rages without various signs of electrical disturbance. On this occasion vivid auroras were seen, not only in both hemispheres, but in latitudes where auroras are very seldom witnessed. They were conspicuous, on the nights following this observation, in Cuba, Rome, South America, and Australia—at Melbourne greater than was ever witnessed there before. Sir John Herschel says:

"These auroras were accompanied with unusually great electro-magnetic disturbances in every part of the world. In many places, the telegraphic wires struck work. They had too many private messages of their own to convey. At Washington and Philadelphia, in America, the telegraphic signal-men received severe electric shocks. At a station in Norway, the telegraphic apparatus was set fire to; and at Boston, in North America, a flame of fire followed the pen of Bain's electric telegraph."

The establishment of so important a fact as the periodicity of the phenomenon of solar spots, and a corresponding periodicity in the action of one of the most subtle of the terrestrial forces, was an event of great moment in the scientific world. For, as the physical forces are correlated and convertible, if any one of them be implicated there arises the presumption that others also may be involved, and a new branch of inquiry is thus opened. Wolf, of Zurich, impressed by the import of the case, addressed himself to the Herculean task of exploring the whole history of past observations of the sun-spots. He overhauled the unknown and forgotten records of old observations, collating the results found in some eleven hundred volumes of print and manuscript, and consulting double that number, which did not pay for the trouble of unearthing them from the dust in which they were buried. His data enable him to give the annual course of the phenomena of spots from 1750 to 1860, that is, for more than a hundred years. For one-half of that time he can make a monthly statement; and is able to trace the maxima and minima with sufficient exactness during the past 140 years. The data procured by Prof. Wolf in this protracted investigation comprehended observations in the seventeenth century on 2,113 days; in the eighteenth century on 5,490 days; in the nineteenth century on 14,860 days, or a total of 22,463 days. The old observers little suspected the ultimate meanings that were to be drawn from what they were doing. But in science nothing is lost; observations at first thought trivial, become at length significant, and serve to establish the most comprehensive views.

It follows from these discoveries that, in the system of the universe, there is reason to rank the sun with the variable stars. How far the phenomena of his spots are linked with planetary influences, is an interesting question to which astronomers are directing their attention. They are also investigating the relations of the sun's spots to the temperature of the earth, and other terrestrial conditions, with results which we have no space left to consider.

THE STUDY OF SOCIOLOGY.

By HERBERT SPENCER.

II.—Is there a Social Science?

ALMOST every autumn may be heard the remark that a hard winter is coming, for that the hips and haws are abundant: the implied belief being that God, intending to send much frost and snow, has provided a large supply of food for the birds. Interpretations of this kind, tacit or avowed, prevail widely. Not many weeks since, one who had received the usual amount of culture said, in my hearing, that the swarm of lady-birds which overspread the country some summers ago had been providentially designed to save the crop of hops from the destroying aphides. Of course this theory of the divine government, extended to natural occurrences bearing but indirectly, if at all, on human welfare, is applied with still greater confidence to occurrences that directly affect us individually and socially. It is a theory carried out with logical consistency by the Methodist who, before going on a journey or removing to another house, opens his Bible, and, in the first passage his eye rests upon, finds an intimation of approval or disapproval from Heaven. And in its political applications it yields such appropriate beliefs as that the welfare of England, in comparison with Continental States, has been a reward for better observance of the Sunday, or that an invasion of cholera was consequent on the omission of *Dei gratia* from an issue of coins.

The interpretation of historical events in general after this same method accompanies such interpretations of less important events; and, indeed, outlives them. Those to whom the natural genesis of similar phenomena has been made manifest by increasing knowledge, still believe in the supernatural genesis of phenomena that are very much involved, and cannot have their causes readily traced. The attitude of mind which, in an official dispatch, prompts the statement that "it has pleased Almighty God to vouchsafe to the British arms the most successful issue to the extensive combinations rendered necessary for the purpose of effecting the passage of the Chenaub,"[1] is an attitude of mind which, in the records of the past, everywhere sees interpositions of the Deity to bring about results that appear to the interpreter the most desirable. Thus, for example, Mr. Schomberg writes:

> "It seemed good to the All-beneficent Disposer of human events, to overrule every obstacle; and through His instrument, William of Normandy, to expurgate the evils of the land; and to resuscitate its dying powers."[2]

[1] Daily paper, January 22, 1849.

[2] The "Theocratic Philosophy of English History," vol. i., p. 49.

And elsewhere:

"The time had now arrived when the Almighty Governor, after having severely punished the whole nation, was intending to raise its drooping head—to give a more rapid impulse to its prosperity, and to cause it to stand forth more prominently as an EXEMPLAR STATE. For this end, He raised up an individual eminently fitted for the intended work [Henry VII.]." [1]

And again:

"As if to mark this epoch of history with greater distinctness, it was closed by the death of George III., the GREAT and the GOOD, who had been raised up as the grand instrument of its accomplishment." [2]

The late catastrophes on the Continent are similarly explained by a French writer who, like the English writer just quoted, professes to have looked behind the veil of things; and who tells us what have been the intentions of God in castigating his chosen people, the French. For it is to be observed in passing that, just as the evangelicals among ourselves think we are divinely blessed because we have preserved the purity of the faith, so it is obvious to the author of "*La Main de l'Homme et le Doigt de Dieu*," as to other Frenchmen, that France is hereafter still to be, as it has hitherto been, the leader of the world. This writer, in chapters entitled "Causes providentielles de nos malheurs," "Les Prussiens et les fléaux de Dieu," and "Justification de la Providence," carries out his interpretations in ways we need not here follow, and then closes his "Epilogue" with these sentences:

"The moderate Revolution, characterized by ability, sagacity, Machiavelism, diabolical wisdom, was vanquished and confounded by Divine Justice in the person and government of Napoleon III.

"The advanced Revolution, full of fervor and headlong audacity, was vanquished and confounded by Divine Justice in the persons and successive governments of Gambetta, Felix Pyat, etc.

"Human wisdom, now everywhere applauded and triumphant, personified by M. Thiers, will quickly be vanquished and confounded by this same Revolution, which, though twice laid low, still is ever springing up again, ever aggressive.

"This is no prophecy: 'tis the foresight of Christian philosophy and faith.

"Then will it be the opportunity of the Most High; for God and his Son must reign through His Gospel and through His Church.

"Frenchmen and Christians! Pray, work, suffer, and have confidence! We are near to the end. When all shall appear to be lost, then shall all be truly saved.

"If France could have known how to profit by the disasters she has suffered, God would have bestowed on her His chiefest favors. But she is stiff-necked in error and vice. Let us be assured that God will save her in spite of herself, regenerating her by water and by fire. When man is powerless, then it is that God's wisdom is displayed. But oh the tribulations, the anguish! Happy

[1] The "Theocratic Philosophy of English History," vol. i., p. 289.
[2] Ibid., vol. ii., p. 681.

they who shall live through all this distress, and who then shall share in the triumph of God, and of His holy Church, catholic, apostolic, and Roman." [1]

Conceptions of this kind are not limited to historians whose names have dropped out of remembrance, and to men who, while the drama of contemporary revolution is going on, play the part of a Greek chorus, telling the world of spectators what has been the divine purpose and what are the divine intentions; but we have lately had a professor of history setting forth conceptions essentially identical in nature. Here are his words:

"And now, gentlemen, was this vast campaign" (of Teutons against Romans) "fought without a general? If Trafalgar could not be won without the mind of a Nelson, or Waterloo without the mind of a Wellington, was there no one mind to lead those innumerable armies on whose success depended the future of the whole human race? Did no one marshal them in that impregnable convex front, from the Euxine to the North Sea? No one guide them to the two great strategic centres of the Black Forest and Trieste? No one cause them, blind barbarians without maps or science, to follow those rules of war without which victory in a protracted struggle is impossible; and, by the pressure of the Huns behind, force on their flagging myriads to an enterprise which their simplicity fancied at first beyond the powers of mortal men? Believe it who will: but I cannot. I may be told that they gravitated into their places, as stones and mud do. Be it so. They obeyed natural laws, of course, as all things do on earth, when they obeyed the laws of war: those, too, are natural laws, explicable on simple mathematical principles. But while I believe that not a stone or a handful of mud gravitates into its place without the will of God; that it was ordained, ages since, into what particular spot each grain of gold should be washed down from an Australian quartz-reef, that a certain man might find it at a certain moment and crisis of his life; if I be superstitious enough (as, thank God, I am!) to hold that creed, shall I not believe that, though this great war had no general upon earth, it may have had a general in heaven? and that, in spite of all their sins, the hosts of our forefathers were the hosts of God." [2]

It does not concern us here to seek a reconciliation of the seemingly incongruous ideas bracketed together in this paragraph—to ask how the results of gravitation, which acts with such uniformity that under given conditions its effect is calculable with certainty, can at the same time be regarded as the results of will, which we class apart because, as known in our experience, it is so irregular; or to ask how, if the course of human affairs is divinely predetermined just as material changes are, any distinction is to be drawn between that prevision of material changes which constitutes physical science and historical prevision: the reader may be left to evolve the obvious conclusion that either the current idea of physical causation has to be abandoned, or the current idea of will has to be abandoned. All which I need here call attention to, as indicating the general character of such historical

[1] "The Hand of Man and the Finger of God in the Misfortunes of France." By J. C., ex-chaplain in the auxiliary army.

[2] "The Roman and the Teuton," pp. 339, 340.

interpretations, is, the remarkable title of the chapter containing this passage—"The Strategy of Providence."

In common with some others, I have often wondered how the universe looks to those who use such names for its cause as "The Master Builder," or "The Great Artificer;" and who seem to think that the cause of the Universe is made more marvellous by comparing its operations to those of a skilled mechanic. But really the expression, "Strategy of Providence," reveals a conception of this cause which is in some respects more puzzling. Such a title as "The Great Artificer," while suggesting simply the process of shaping a preëxisting material, and leaving the question whence this material came untouched, may at any rate be said not to negative the assumption that the material is also created by the Great Artificer who shapes it. The phrase, "Strategy of Providence," however, necessarily implies difficulties to be overcome. The Divine Strategist must have a skilful antagonist to make strategy possible. So that we are inevitably introduced to the conception of a cause of the universe continually impeded by some independent cause which has to be outgeneralled. It is not every one who would thank God for a belief, the implication of which is that God is obliged to overcome opposition by subtle devices.

The disguises which piety puts on are, indeed, not unfrequently suggestive of that which some would describe by a quite opposite name. To study the Universe as it is manifested to us; to ascertain by patient observation the order of the manifestations; to discover that the manifestations are connected with one another after a regular way in time and space; and, after repeated failures, to give up as futile the attempt to understand the power manifested; is condemned as irreligious. And meanwhile the character of religious is claimed by those who figure to themselves a Creator moved by motives like their own; conceive themselves as discovering his designs; and even speak of him as though he laid plans to outwit the devil.

This, however, by the way. The foregoing extracts and comments are intended to indicate the mental attitude of those for whom there can be no such thing as Sociology, properly so called. That mode of conceiving human affairs which is implied alike by the "D. V." of a missionary-meeting placard and by the phrases of Emperor William's late dispatches, where thanks to God come next to enumerations of the thousands slain, is one to which the idea of a social science is entirely alien, and indeed repugnant.

An allied class, equally unprepared to interpret sociological phenomena scientifically, is the class which sees in the course of civilization little else than a record of remarkable persons and their doings. One who is conspicuous as the exponent of this view writes: "As I take it, universal history, the history of what man has accomplished in this world is at bottom the history of the great men who have worked

here." And this, not perhaps distinctly formulated, but everywhere implied, is the belief in which nearly all men are brought up. Let us glance at the genesis of it.

Round their camp-fire assembled savages tell the events of the day's chase; and he among them who has done some feat of skill or agility is duly lauded. On a return from the war-path, the sagacity of the chief, and the strength or courage of this or that warrior, are the all-absorbing themes. When the day, or the immediate past, affords no remarkable deed, the topic is the achievement of some noted leader lately dead, or some traditional founder of the tribe: accompanied, it may be, with a dance dramatically representing those victories which the chant recites. Such narratives, concerning as they do the prosperity and indeed the very existence of the tribe, are of the intensest interest; and in them we have the common root of music, of the drama, of poetry, of biography, of history, and of literature in general. Savage life furnishes little else worthy of note; and the chronicles of tribes contain scarcely any thing more to be remembered. Early historic races show us the same thing. The Egyptian frescoes and the wall-sculptures of the Assyrians represent the deeds of their chief men; and inscriptions such as that on the Moabite stone tell of nothing more than royal achievements: only by implication do these records, pictorial, hieroglyphic, or written, convey any thing else. And similarly from the Greek epic: though we gather incidentally that there were towns, and war-vessels, and war-chariots, and sailors, and soldiers to be led and slain, yet the direct intention is to set forth the triumphs of Achilles, the prowess of Ajax, the wisdom of Ulysses, and the like. The lessons given to every civilized child tacitly imply, like the traditions of the uncivilized and semi-civilized, that throughout the past of the human race the doings of the leading persons have been the only things worthy to be chronicled. How Abraham girded up his loins and gat him to this place or that; how Samuel conveyed divine injunctions which Saul disobeyed; how David recounted his adventures as a shepherd, and was reproached for his misdeeds as a king—these, and personalities akin to these, are the facts about which the juvenile reader of the Bible is interested and respecting which he is catechised: such indications of Jewish institutions as have unavoidably got into the narrative being regarded neither by him nor by his teacher as of moment. So too, when, with hands behind him, he stands to say his lesson out of "Pinnock," we see that the things set down for him to learn are—when and by whom England was invaded; what rulers opposed the invasions and how they were killed; what Alfred did and what Canute said; who fought at Agincourt and who conquered at Flodden; which king abdicated and which usurped, etc.; and if by some chance it comes out that there were serfs in those days, that barons were local rulers, some vassals of others, that subordination of them to a central rule took place gradually, these are facts

treated as relatively unimportant. Nay, the like happens when the boy passes into the hands of his classical master, at home or elsewhere. "Arms and the man" form the end of the story as they form its beginning. After the mythology, which of course is all-essential, come the achievements of rulers and soldiers from Agamemnon down to Cæsar: what knowledge is gained of social organization, manners, ideas, morals, being such only as the biographical statements involved. And the value of the knowledge is so ranked that while it would be a disgrace to be wrong about the amours of Zeus, and while ignorance concerning the battle of Marathon would be discreditable, it is excusable to know little or nothing of the social arrangements that preceded Lycurgus or the origin and functions of the Areopagus.

Thus the great-man theory of history finds everywhere a ready-prepared conception—is, indeed, but the definite expression of that which is latent in the thoughts of the savage, tacitly asserted in all early traditions, and taught to every child by multitudinous illustrations. The glad acceptance it meets with has sundry more special causes. There is, first, this universal love of personalities, which, active in the aboriginal man, dominates still—a love seen in the child which asks you to tell it a story, meaning, thereby, somebody's adventures; a love gratified in adults by police-reports, court-news, divorce-cases, accounts of accidents, and lists of births, marriages, and deaths; a love displayed even by conversations in the streets, where fragments of dialogue, heard in passing, prove that mostly between men, and always between women, the personal pronouns recur every instant. If you want roughly to estimate any one's mental calibre, you cannot do it better than by observing the ratio of generalities to personalities in his talk—how far simple truths about individuals are replaced by truths abstracted from numerous experiences of man and things. And, when you have thus measured many, you find but a scattered few likely to take any thing more than a biographical view of human affairs.

In the second place, this great-man theory commends itself as promising instruction along with gratification. Being already fond of hearing about people's sayings and doings, it is pleasant news that, to understand the course of civilization, you have only to read diligently the lives of conspicuous men. What can be a more acceptable doctrine than that while you are satisfying an instinct not very remotely allied to that of the village gossip—while you are receiving through print, instead of orally, remarkable facts concerning notable persons—you are gaining that knowledge which will make clear to you why things have happened thus or thus in the world, and will prepare you for forming a right opinion on each question coming before you as a citizen?

And then, in the third place, the interpretation of things thus given is so beautifully simple—seems so easy to comprehend. Providing you are content with conceptions that are out of focus, as most people's

conceptions are, the solutions it yields appear quite satisfactory. Just as that theory of the Solar System, which supposes the planets to have been launched into their orbits by the hand of the Almighty, looks quite feasible so long as you do not insist on knowing exactly what is meant by the hand of the Almighty; and just as the special creation of plants and animals seems a satisfactory hypothesis until you try and picture to yourself definitely the process by which one of them is brought into existence; so the genesis of social phenomena through the agency of great men may be very comfortably believed so long as, resting in general notions, you do not ask for particulars.

But now, if, dissatisfied with vagueness, we demand that our ideas should be brought into focus and exactly defined, we discover the hypothesis to be utterly incoherent. If, not stopping at the explanation of social progress as due to the great man, we go back a step and ask whence comes the great man, we find that the theory breaks down completely. The question has two conceivable answers: his origin is supernatural, or it is natural. Is his origin supernatural? Then he is a deputy-god, and we have Theocracy once removed—or, rather, not removed at all; for we must then agree with Mr. Schomberg, quoted above, that "the determination of Cæsar to invade Britain" was divinely inspired, and that from him, down to "George III., the GREAT and the GOOD," the successive rulers were appointed to carry out successive designs. Is this an unacceptable solution? Then the origin of the great man is natural; and immediately he is thus recognized he must be classed with all other phenomena in the society that gave him birth, as a product of its antecedents. Along with the whole generation of which he forms a minute part—along with its institutions, language, knowledge, manners, and its multitudinous arts and appliances, he is a resultant of an enormous aggregate of causes that have been coöperating for ages. True, if you please to ignore all that common observation, verified by physiology, teaches—if you assume that two European parents may produce a Negro child, or that from woolly-haired prognathous Papuans may come a fair, straight-haired infant of Caucasian type—you may assume that the advent of the great man can occur anywhere and under any conditions. If, disregarding those accumulated results of experience which current proverbs and the generalizations of psychologists alike express, you suppose that a Newton might be born in a Hottentot family, that a Milton might spring up among the Andamanese, that a Howard or a Clarkson might have Fiji parents, then you may proceed with facility to explain social progress as caused by the actions of the great man. But if all biological science, enforcing all popular belief, convinces you that by no possibility will an Aristotle come from a father and mother with facial angles of fifty degrees, and that out of a tribe of cannibals, whose chorus in preparation for a feast of human flesh is a kind of rhythmical roaring, there is not the remotest chance of a Beethoven

arising; then you must admit that the genesis of the great man depends on the long series of complex influences which has produced the race in which he appears, and the social state into which that race has slowly grown. If it be a fact that the great man may modify his nation in its structure and actions, it is also a fact that there must have been those antecedent modifications constituting national progress before he could be evolved. Before he can remake his society, his society must make him. So that all those changes of which he is the proximate initiator have their chief causes in the generations which gave him birth. If there is to be any thing like a real explanation of these changes, it must be sought in that aggregate of conditions out of which both he and they have arisen.

Even were we to grant the absurd supposition that the genesis of the great man does not depend on the antecedents furnished by the society he is born in, there would still be the quite-sufficient facts that he is powerless in the absence of the material and mental accumulations which his society inherits from the past, and that he is powerless in the absence of the coexisting population, character, intelligence, and social arrangements. Given a Shakespeare, and what dramas could he have written without the multitudinous traditions of civilized life—without the various experiences which, descending to him from the past, gave wealth to his thought, and without the language which a hundred generations had developed and enriched by use? Suppose a Watt, with all his inventive power, living in a tribe ignorant of iron, or in a tribe that could get only as much iron as a fire blown by hand-bellows will smelt; or suppose him born among ourselves before lathes existed; what chance would there have been of the steam-engine? Imagine a Laplace unaided by that slowly-developed system of Mathematics which we trace back to its beginnings among the Egyptians; how far would he have got with the "*Mécanique Céleste?*" Nay, the like questions may be put and have like answers, even if we limit ourselves to those classes of great men on whose doings hero-worshippers more particularly dwell—the conquering rulers and generals. Xenophon could not have achieved his celebrated feat had his Ten Thousand been feeble, or cowardly, or insubordinate. Cæsar would never have made his conquests without disciplined troops inheriting their *prestige* and tactics and organization from the Romans who lived before them. And, to take a recent instance, the strategical genius of Moltke would have gained no great campaigns had there not been a nation of some forty millions to supply soldiers, and had not those soldiers been men of strong bodies, sturdy characters, obedient natures, and capable of carrying out orders intelligently.

Were any one to marvel over the potency of a grain of detonating powder, which explodes a cannon, propels the shell, and sinks a vessel hit—were he to enlarge on the transcendent virtues of this detonating powder, not mentioning the ignited charge, the shell, the cannon, and

all that enormous aggregate of appliances by which these have severally been produced, detonating powder included, we should not regard his interpretation as very rational. But it would fairly compare in rationality with this interpretation of social phenomena which, dwelling on the important changes which the great man works, ignores that immense preëxisting supply of latent power which he unlocks, and that immeasurable accumulation of antecedents to which both he and this power are due.

Recognizing what truth there is in the great-man theory of history, we may say that, if limited to early societies, the histories of which are histories of little else than endeavors to destroy or subjugate one another, it approximately expresses the fact in representing the capable leader as all-important; though even here it leaves out of sight too much the number and the quality of his followers. But its immense error lies in the assumption that what was once true is true forever; and that a relation of ruler and ruled which was possible and good at one time is possible and good for all time. Just as fast as this predatory activity of early tribes diminishes, just as fast as larger aggregates are formed by conquest or otherwise, just as fast as war ceases to be the business of the whole male population, so fast do societies begin to develop, to show traces of structures and functions not before possible, to acquire increasing complexity along with increasing size, to give origin to new institutions, new activities, new ideas, sentiments, and habits: all of which unobtrusively make their appearance without the thought of any king or legislator. And if you wish to understand these phenomena of social evolution, you will not do it though you should read yourself blind over the biographies of all the great rulers on record, down to Frederick the Greedy and Napoleon the Treacherous.

In addition to that passive denial of a Social Science implied by these two allied doctrines, one or other of which is held by nine men out of ten, there comes from a few an active denial of it—either entire or partial. Reasons are given for the belief that no such thing is possible. The essential invalidity of these reasons can be shown only after the essential nature of Social Science, overlooked by those who make them, has been pointed out; and to point this out here would be to forestall the argument. Some minor criticisms, may, however, fitly precede the major criticism. Let us consider first the positions taken up by Mr. Froude:

"When natural causes are liable to be set aside and neutralized by what is called volition, the word Science is out of place. If it is free to a man to choose what he will do or not do, there is no adequate science of him. If there is a science of him, there is no free choice, and the praise or blame with which we regard one another is impertinent and out of place."[1]

[1] "Short Studies on Great Subjects," vol. i., p. 11.

"It is in this marvellous power to do wrong . . . . that the impossibility stands of forming scientific calculations of what men will do before the fact, or scientific explanations of what they have done after the fact."[1]

Mr. Buckle "would deliver himself from the eccentricities of this and that individual by a doctrine of averages. . . . Unfortunately, the average of one generation need not be the average of the next. . . . No two generations are alike."[2]

"There" (in history) "the phenomena never repeat themselves. There we are dependent wholly on the record of things said to have happened once, but which never happen or can happen a second time. There no experiment is possible; we can watch for no recurring fact to test the worth of our conjectures."[3]

Here Mr. Froude chooses, as the ground on which to join issue, the old battle-ground of free-will *versus* necessity: declaring a Social Science to be incompatible with free-will. The first extract implies, not simply that individual volition is incalculable—that "there is no adequate science of" man, no science of Psychology; but it also asserts, by implication, that there are no causal relations among his states of mind: the volition by which "natural causes are liable to be set aside," being put in antithesis to natural, must be supernatural. Hence we are, in fact, carried back to that primitive form of interpretation contemplated at the outset.

A further comment is, that because volitions of some kinds cannot be foreseen, Mr. Froude concludes that no volitions can be foreseen: ignoring the fact that the simple volitions determining ordinary conduct are so regular that prevision having a high degree of probability is easy. If, in crossing a street, a man sees a carriage coming upon him, you may safely assert that, in nine hundred and ninety-nine cases out of a thousand, he will try to get out of the way. If, being pressed to catch a train, he knows that by one route it is a mile to the station and by another two miles, you may conclude with considerable confidence that he will take the one-mile route; and, should he be aware that losing the train will lose him a fortune, it is pretty certain that, if he has but ten minutes to do the mile in, he will either run or call a cab. If he can buy next door a commodity of daily consumption better and cheaper than at the other end of the town, we may affirm that, if he does not buy next door, some special relation between him and the remoter shopkeeper furnishes a strong reason for taking a worse commodity at greater cost of money and trouble. And though, if he has an estate to dispose of, it is within the limits of possibility that he will sell it to A for £1,000 though B has offered £2,000 for it; yet the unusual motives leading to such an act need scarcely be taken into account as qualifying the generalization that a man will habitually sell to the highest bidder. Now, since the predominant activities of citizens are determined by motives of this degree of regularity, there

[1] "Short Studies on Great Subjects," vol. i., p. 24.
[2] Ibid., vol. i., p. 22. [3] Ibid., vol. i., p. 15.

must be resulting social phenomena that have corresponding degrees of regularity—greater degrees, in fact; since in them the effects of exceptional motives become lost in the effects of the aggregate of ordinary motives.

Another comment may be added. Mr. Froude exaggerates the antithesis he draws by using a conception of science which is far too narrow—a conception seemingly limited to *exact* science. Scientific previsions, both qualitative and quantitative, have various degrees of definiteness; and, because among certain classes of phenomena the previsions are but approximate, it is not, therefore, to be said that there is no science of those phenomena: if there is some prevision, there is some science. Take, for example, Meteorology. The Derby has been run in a snow-storm, and you may occasionally want a fire in July; but such anomalies do not prevent us from being perfectly certain that the coming summer will be warmer than the past winter. Our south-westerly gales in the autumn may come early or may come late, may be violent or moderate, at one time or at intervals; but that winds will be in excess from that quarter at that part of the year we may be quite sure: and similarly with the northeasterly winds during the spring and early summer. The like holds with the relations of rain and dry weather to the quantity of water in the air and the weight of the atmospheric column: though exactly true predictions cannot be made, approximately true ones can. So that, even were there not among social phenomena more definite relations than these (and the all-important ones are far more definite), there would still be a Social Science.

Once more, Mr. Froude contends that the facts presented in history do not furnish subject-matter for science, because they "never repeat themselves," because "we can watch for no recurring fact to test the worth of our conjectures." I will not meet this assertion by the counter-assertion often made, that historic phenomena *do* repeat themselves; but, admitting that Mr. Froude here touches on one of the great difficulties of the Social Science (that social phenomena are in so considerable a degree different in each case from what they were in preceding cases), I still find a sufficient reply. For in no concrete science is there any absolute repetition; and in some concrete sciences the repetition is no more specific than in Sociology. Even in the most exact of them, Astronomy, the combinations are never the same twice over: the repetitions are but approximate. And on turning to Geology, we find that, though the processes of denudation, deposition, upheaval, subsidence, have been ever going on in conformity with laws more or less clearly generalized, the effects have been always new in their proportions and arrangements; though not so completely new as to forbid comparisons, consequent deductions, and approximate previsions based on them.

Were there no such replies as these to Mr. Froude's reasons, there

would still be the reply furnished by his own interpretations of history; which make it clear that his denial must be understood as but a qualified one. Against his professed theory may be set his actual practice, which, as it seems to me, tacitly asserts that explanations of some social phenomena in terms of cause and effect are possible, if not explanations of all social phenomena. Thus, respecting the Vagrancy Act of 1547, which made a slave of a confirmed vagrant, Mr. Froude says: "In the condition of things which was now commencing . . . . neither this nor any other penal act against idleness could be practically enforced."[1] That is to say, the operation of an agency brought into play was neutralized by the operation of natural causes coexisting. Again, respecting the enclosure of commons and amalgamation of farms, etc., Mr. Froude writes: "Under the late reign these tendencies had, with great difficulty, been held partially in check, but on the death of Henry they acquired new force and activity."[2] Or, in other words, certain social forces previously antagonized by certain other forces produced their natural effects when the antagonism ceased. Yet again, Mr. Froude explains that "unhappily, two causes" (debased currency and an alteration of the farming system) "were operating to produce the rise of prices."[3] And throughout Mr. Froude's "History of England" there are, I need scarcely say, other cases in which he ascribes social changes to causes rooted in human nature; though, in the lecture from which I have quoted, he alleges the "impossibility of forming scientific calculations of what men will do before the fact, or scientific explanations of what they have done after the fact."

Another writer who denies the possibility of a Social Science, or who at any rate admits it only as a science that has its relations of phenomena so traversed by providential influences that it does not come within the proper definition of a science, is Canon Kingsley. In his address on the "Limits of Exact Science as appled to History" he says:

"You say that, as the laws of matter are inevitable, so probably are the laws of human life? Be it so: but in what sense are the laws of matter inevitable? Potentially or actually? Even in the seemingly most uniform and universal law, where do we find the inevitable or the irresistible? Is there not in Nature a perpetual competition of law against law, force against force, producing the most endless and unexpected variety of results? Cannot each law be interfered with at any moment by some other law, so that the first law, though it may struggle for the mastery, shall be for an indefinite time utterly defeated? The law of gravity is immutable enough: but do all stones veritably fall to the ground? Certainly not, if I choose to catch one, and keep it in my hand. It remains there by laws; and the law of gravity is there, too, making it feel heavy in my hand: but it has not fallen to the ground, and will not, till I let it. So much for the inevitable action of the laws of gravity, as of others. Potentially, it is immutable; but actually, it can be conquered by other laws."[4]

[1] "History of England," vol. v., p. 70.
[2] Ibid., vol. v., p. 108.
[3] Ibid., vol. v., p. 109
[4] Page 20.

This passage, severely criticised, if I remember rightly, when the address was originally published, it would be scarcely fair to quote, were it not that Canon Kingsley has repeated it at a later date in his work, "The Roman and the Teuton." The very unusual renderings of scientific ideas which it contains need here be only enumerated. Mr. Kingsley differs profoundly from philosophers and men of science, in regarding a law as itself a power or force, and so in thinking of one law as "conquered by other laws;" whereas the accepted conception of law is that of an established *order*, to which the manifestations of a power or force conform. He enunciates, too, a quite exceptional view of gravitation. As conceived by astronomers and physicists, gravitation is a universal and ever-acting *force*, which portions of matter exercise on one another when at sensible distances; and the *law* of this force is that it varies inversely as the square of the distance. Mr. Kingsley's view, however, appears to be that the law of gravitation is "defeated" if a stone is prevented from falling to the ground—that the law "struggles" (not the force), and that because it no longer produces motion, the "inevitable action of the laws of gravity" (not of gravity) is suspended: the truth being that neither the force nor its law is in the slightest degree modified. Further, the theory of natural processes which Mr. Kingsley has arrived at seems to be, that when two or more forces (or laws, if he prefers it) come into play, there is a partial or complete suspension of one by another. Whereas, the doctrine held by men of science is, that the forces are all in full operation, and the effect is their resultant; so that, for example, when a shot is fired horizontally from a cannon, the force impressed on it produces in a given time just the same amount of horizontal motion as though gravity were absent, while gravity produces in that same time a fall just equal to that which it would have produced had the shot been dropped from the mouth of the cannon. Of course, holding these peculiar views of causation as displayed among simple physical phenomena, Canon Kingsley is consistent in denying historical sequence; and in saying that, "as long as man has the mysterious power of breaking the laws of his own being, such a sequence not only cannot be discovered, but it cannot exist."[1] At the same time it is manifest that, until he comes to some agreement with men of science respecting conceptions of forces, of their laws, and of the modes in which phenomena produced by compositions of forces are interpretable in terms of compound laws, no discussion of the question at issue can be carried on with profit.

Without waiting for such an agreement, however, which is probably somewhat remote, Canon Kingsley's argument may be met by putting side by side with it some of his own conclusions set forth elsewhere. In an edition of "Alton Locke" published since the delivery of the address above quoted from, there is a new preface, containing, among others, the following passages:

[1] Page 22.

"The progress toward institutions more and more popular may be slow, but it is sure. Whenever any class has conceived the hope of being fairly represented, it is certain to fulfil its own hopes, unless it employs or provokes, violence, impossible in England. The thing will be[1] . . . .

"If any young gentlemen look forward . . . . to a Conservative reaction of any other kind than this . . . . to even the least stoppage of what the world calls progress—which I should define as the putting in practice the results of inductive science—then do they, like King Picrochole in Rabelais, look for a kingdom which shall be restored to them at the coming of the Cocqcigrues."[2]

And in a preface addressed to working-men, contained in an earlier edition, he says:—

"If you are better off than you were in 1848, you owe it principally to those laws of political economy (as they are called) which I call the brute natural accidents of supply and demand, etc."[3]

Which passages offer explanations of changes now gone by as having been wrought out by natural forces in conformity with natural laws, and also predictions of changes which social forces at present in action will work out. That is to say, by the help of generalized experiences there is an interpretation of past phenomena and a prevision of future phenomena. There is an implicit recognition of that Social Science which is explicitly denied.

A reply to these criticisms may be imagined. In looking for whatever reconciliation seems possible between these positions, which seem so incongruous, we must suppose the intended assertion to be, that general interpretations and previsions only can be made, not those which are special. Bearing in mind Mr. Froude's occasional explanations of historical phenomena as naturally caused, we must conclude that he believes certain classes of sociological facts (as the politico-economical) to be scientifically explicable, while other classes are not; though, if this be his view, it is not clear how, if the results of men's wills, separate or aggregated, are incalculable, politico-economical actions can be dealt with scientifically, since, equally with other social actions, they are determined by aggregated wills. Similarly, Canon Kingsley, recognizing no less distinctly economical laws, and enunciating also certain laws of progress—nay, even warning his hearers against the belief that he denies the applicability of the inductive method to social phenomena—must be assumed to think that the applicability of scientific methods is here but partial. Citing the title of his address, he will possibly hold its implication to be merely that there are limits to the explanation of social facts in precise ways; though this position does not seem really reconcilable with the doctrine that social laws are liable to be at any time suspended, providentially or otherwise.

[1] "Alton Locke," new edition, preface, p. xxi.

[2] Ibid., preface (1854), p. xxvii.

[3] Ibid., pp. xxiii., xxiv.

But, merely hinting these collateral criticisms, this reply is to be met by the demurrer that it is beside the question. If the sole thing meant is that sociological previsions can be approximate only—if the thing denied is the possibility of reducing Sociology to the form of an exact science—then the rejoinder is, that the thing denied is a thing which no one has affirmed. Only a moiety of science is exact science—only phenomena of certain orders have had their relations developed from the qualitative form into the quantitative form. Of the remaining orders there are some produced by factors so numerous and so difficult to measure, that development of their relations into the quantitative form is extremely improbable, if not impossible. But these orders of phenomena are not therefore excluded from the conception of Science. In Geology, in Biology, in Psychology, most of the previsions are qualitative only; and where they are quantitative their quantitativeness, never quite definite, is mostly very indefinite. Nevertheless we unhesitatingly class these previsions as scientific. Similarly with Sociology. The phenomena it presents, involved in a higher degree than all others, are less than all other capable of precise treatment: such of them as can be generalized, can be generalized only within wide limits of variation as to time and amount; and there remains much that cannot be generalized. But, so far as there can be generalization, and so far as there can be interpretation based on it, so far there can be science. Whoever expresses political opinions—whoever asserts that such or such public arrangements will be beneficial or detrimental, tacitly expresses a belief in Social Science; for he asserts, by implication, that there is a natural sequence among social actions, and that, as the sequence is natural, results may be foreseen.

Reduced to a more concrete form, the case may be put thus: Mr. Froude and Canon Kingsley both believe to a considerable extent in the efficiency of legislation—probably to a greater extent than it is believed in by some of those who assert the existence of a Social Science. To believe in the efficiency of legislation is to believe that certain prospective penalties or rewards will act as deterrents or incentives—will modify individual conduct, and therefore modify social action. Though it may be impossible to say that a given law will produce a foreseen effect on a particular person, yet no doubt is felt that it will produce a foreseen effect on the mass of persons. Though Mr. Froude, when arguing against Mr. Buckle, says that he "would deliver himself from the eccentricities of this and that individual by a doctrine of averages," but that "unfortunately, the average of one generation need not be the average of the next;" yet Mr. Froude himself so far believes in the doctrine of averages as to hold that legislative interdicts, with threats of death or imprisonment behind them, will restrain the great majority of men in ways which can be predicted. While he contends that the results of individual will are incalculable, yet, by approving certain laws and condemning others, he tacitly

affirms that the results of the aggregate of wills are calculable. And, if this be asserted of the aggregate of wills as affected by legislation, it must be asserted of the aggregate of wills as affected by social influences at large. If it be held that the desire to avoid punishment will so act on the average of men as to produce an average foreseen result; then it must also be held that, on the average of men, the desire to get the greatest return for labor, the desire to rise into a higher rank of life, the desire to gain applause, and so forth, will each of them produce a certain average result. And to hold this is to hold that there can be prevision of social phenomena, and therefore Social Science.

In brief, then, the alternative positions are these: On the one hand, if there is no natural causation throughout the actions of incorporated humanity, government and legislation are absurd. Acts of Parliament may, as well as not, be made to depend on the drawing of lots or the tossing of a coin; or rather there may as well be none at all: social sequences having no ascertainable order, no effect can be counted upon—every thing is anarchic. On the other hand, if there is such natural causation, then the combination of forces, by which every effect or combination of effects is produced, produces them in conformity with the laws of the forces. And if so, it behooves us to use all diligence in ascertaining what the forces are, what are their laws, and what are the ways in which they coöperate.

Such further elucidation as is possible will be gained by discussing the question to which we now address ourselves—the Nature of the Social Science. Along with a definite idea of this, will come a perception that the denial of a Social Science has arisen from the confusing of two essentially different classes of phenomena which societies present—the one class, almost ignored by historians, constituting the subject-matter of Social Science, and the other class, almost exclusively occupying them, admitting of scientific coördination in a very small degree, if at all.

EFFECTS OF FAULTY VISION IN PAINTING.[1]

By R. LIEBREICH,

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WHEN I arrived in England about eighteen months ago, little thinking that a short vacation tour would end in my permanent residence here, I at once paid a visit to the National Gallery. I was anxious to see Turner's pictures, which on the Continent I had had no opportunity of doing. How great was my astonishment when, after

[1] A lecture delivered at the Royal Institution on March 8, 1872.

having admired his earlier works, I entered another room which contained his later paintings! Are these really by the same hand? I asked myself on first inspecting them; or have they suffered in any way? On examining them, however, more closely, a question presented itself to my mind which was to me a subject of interesting diagnosis. Was the great change, which made the painter of "Crossing the Brook" afterward produce such pictures as "Shade and Darkness," caused by an ocular or cerebral disturbance? Researches into the life of Turner could not afford an answer to this question. All that I could learn was, that during the last five years of his life his power of vision as well as his intellect had suffered. In no way, however, did this account for the changes which began to manifest themselves about fifteen years before that time. The question could therefore only be answered by a direct study of his pictures from a purely scientific, and not at all from an æsthetic or artistic point of view.

I chose for this purpose pictures belonging to the middle of the period which I consider pathological, i. e., not quite healthy, and analyzed them in all their details, with regard to color, drawing, and distribution of light and shade.

It was particularly important to ascertain if the anomaly of the whole picture could be deduced from a regularly-recurring fault in its details. This fault is a vertical streakiness, which is caused by every illuminated point having been changed into a vertical line. The elongation is, generally speaking, in exact proportion to the brightness of the light; that is to say, the more intense the light which diffuses itself from the illuminated point in Nature, the longer becomes the line which represents it on the picture. Thus, for instance, there proceeds from the sun in the centre of a picture a vertical yellow streak, dividing it into two entirely distinct halves, which are not connected by any horizontal line. In Turner's earlier pictures, the disk of the sun is clearly defined, the light equally radiating to all parts; and, even where through the reflection of water a vertical streak is produced, there appears, distinctly marked through the vertical streak of light, the line of the horizon, the demarcation of the land in the foreground, and the outline of the waves in an horizontal direction. In the pictures, however, of which I am now speaking, the tracing of any detail is perfectly effaced when it falls in the vertical streak of light. Even less illuminated objects, like houses or figures, form considerably elongated streaks of light. In this manner, therefore, houses that stand near the water, or people in a boat, blend so entirely with the reflection in the water, that the horizontal line of demarcation between house and water or boat and water entirely disappears, and all becomes a conglomeration of vertical lines. Every thing that is abnormal in the shape of objects, in the drawing, and even in the coloring of the pictures of this period, can be explained by this vertical diffusion of light.

How and at what time did this anomaly develop itself?

Till the year 1830 all is normal. In 1831 a change in the coloring becomes for the first time perceptible, which gives to the works of Turner a peculiar character not found in any other master. Optically this is caused by an increased intensity of the diffused light proceeding from the most illuminated parts of the landscape. This light forms a haze of a bluish color which contrasts too much with the surrounding portion in shadow. From the year 1833 this diffusion of light becomes more and more vertical. It gradually increases during the following years. At first it can only be perceived by a careful examination of the picture, but from the year 1839 the regular vertical streaks become apparent to every one. This increases subsequently to such a degree that, when the pictures are closely examined, they appear as if they had been wilfully destroyed by vertical strokes of the brush before they were dry, and it is only from a considerable distance that the object and the meaning of the picture can be comprehended. During the last years of Turner's life, this peculiarity became so extreme that his pictures can hardly be understood at all.

It is a generally-received opinion that Turner adopted a peculiar manner, that he exaggerated it more and more, and that his last works are the result of a deranged intellect. I am convinced of the incorrectness, I might almost say of the injustice, of this opinion. The word "manner" has a very vague meaning. In general we understand by it something which has been arbitrarily assumed by the artist. It may be the result of study, of reflection, of a development of principle, or the consequence of a chance observation, of an experiment, or of an occasional success. Nothing of all this applies to what has been called Turner's manner. Nothing in him is arbitrary, assumed, or of set purpose. According to my opinion, his manner is exclusively the result of a change in his *eyes*, which developed itself during the last twenty years of his life. In consequence of it the aspect of Nature gradually changed for him, while he continued in an unconscious, I might almost say in a *naïve* manner, to reproduce what he saw. And he reproduced it so faithfully and accurately, that he enables us distinctly to recognize the nature of the disease of his eyes, to follow its development step by step, and to prove by an optical contrivance the correctness of our diagnosis. By the aid of this contrivance we can see Nature under the same aspect as he saw and represented it. With the same we can also, as I shall prove to you by an experiment, give to Turner's early pictures the appearance of those of the later period.

After he had reached the age of fifty-five, the crystalline lenses of Turner's eyes became rather dim, and dispersed the light more strongly, and in consequence threw a bluish mist over illuminated objects. This is a pathological increase of an optical effect, the existence of which, even in the normal eye, can be proved by the following experiment:

If you look at a picture which hangs between two windows, you will not be able to see it distinctly, as it will be, so to speak, veiled by a grayish haze. But, if you hold your hands before your eyes so as to shade them from the light of the windows, the veiling mist disappears, and the picture becomes clearly visible. The disturbing light had been diffused by the refracting media of the eye, and had fallen on the same part of the retina on which the picture was formed. If we examine the eye by an illumination resembling that by means of which Prof. Tyndall, in his brilliant experiments, demonstrated to you the imperfect transparency of water, we find that even the clearest and most beautiful eye is not so perfectly transparent as we would suppose. The older we get the more the transparency decreases, especially of the lens. But, to produce an effect equal to that visible in Turner's pictures after the year 1831, pathological conditions are required. In the years that followed, as often happens in such cases, a clearly-defined opacity was formed in the slight and diffuse dimness of the crystalline lens. In consequence of this the light was no longer evenly diffused in all directions, but principally dispersed in a vertical direction. At this period the alteration offers, in the case of a painter, the peculiarity that it only affects the appearance of natural objects, where the light is strong enough to produce this disturbing effect, while the light of his painting is too feeble to do so: therefore, the aspect of Nature is altered; that of his picture correct. Only within the last years of Turner's life, the dimness had increased so much, that it prevented him from seeing even his pictures correctly. This sufficiently accounts for the strange appearance of his last pictures, without its being necessary to take into account the state of his mind.

It may seem hazardous to designate a period as diseased, the beginning of which art-critics and connoisseurs have considered as his climax. I do not think that the two opinions are in decided contradiction to each other. To be physiologically normal is not at all a fundamental condition in art; and we cannot deny the legitimacy of the taste which regards that which is entirely sound and healthy as commonplace, trivial, and uninteresting, and which on the contrary is fascinated by that which approaches the border of disease and even goes beyond it.

Many of the best musicians, for instance, and some of the greatest admirers of Beethoven, prefer his latest works, and consider them the most interesting, although the influence of his deafness upon them is apparent to others.

In poetry, we rank some poems among the highest productions of art, in which the imagination of the poet goes far beyond the normal region of the mind:

> "The poet's eye, in a fine frenzy rolling,
> Doth glance from heaven to earth, from earth to heaven."

Thus it seems to me perfectly natural that the peculiar poetical

haze which is produced by the diffusion of light in Turner's pictures after 1831 should have a particular attraction for many of Turner's admirers. On the other hand, passing over the faults, we discover in these pictures peculiar merits, and we recognize that the great artist continued in many ways to improve, even at a time of his life when his failing sight began to deprive his works of general favor. I cannot, however, defend the opinion of those who are enraptured with Turner's pictures belonging to a still later period—who consider a picture beautiful which, in consequence of this optical defect, is entirely disfigured and defaced, and who, calling this Turner's style, would like to form it into a school and imitate it. They resemble the porter of a certain dealer in works of art, who one day, when he had to deliver the torso of a Venus at a gentleman's house, answered the servant, who had expressed his astonishment that his master should have bought a thing without head, arms, or legs, "You don't understand; that's just the beauty of it."

I show you here first a picture which is copied from an oil-painting in the South-Kensington Museum. This picture was not exhibited till the year 1833, but it was painted some time before, and from sketches taken in Venice previous to any change in Turner's sight. I shall now try so to change this picture, by an optical contrivance, as to make it resemble the pictures he painted after 1839. You must, of course, not expect to see in this rough representation, which a large theatre necessitates, any thing of the real beauty of Turner's pictures. Our object is to analyze their faults.

In order to show you in a single object what you have already observed in the general aspect of a picture, I choose purposely a tree, because there are no trees in the "Venice" you have just seen, and more particularly because after the year 1833 Turner painted trees that were unknown to any botanist, had never been seen in Nature, nor been painted by any other artist. I do not think it likely that Turner invented a tree he had never seen; it seems to me more probable that he painted such trees because he saw them so in Nature. I searched for them with the aid of the lens, and soon discovered them. Here is a common tree; the glass changes it into a Turner tree.

Let us now turn from the individual case of a great artist to a whole category of cases, in which the works of painters are modified by anomalies in their vision—I mean cases of irregularities in the refraction of the eye. The optical apparatus of the eye forms, like the apparatus of a photographer, inverted images. In order to be seen distinctly, these images must fall exactly upon the retina. The capacity of the eye to accommodate itself to different consecutive distances, so as to receive on the retina distinct images of objects, is called accommodation. This faculty depends upon the power of the crystalline lens to change its form. The accommodation is at its

greatest tension if we adapt our eye to the nearest point. It is, on the contrary, in complete repose if we adapt it to the farthest point. The optical state of the eye during its adaptation for the farthest point, when every effort of accommodation is completely suspended, is called its refraction.

There are three different kinds of refraction: firstly, that of the normal eye; secondly, of the short-sighted eye; thirdly, of the over-sighted eye:

1. The normal eye, when the activity of its accommodation is perfectly suspended, is adjusted for the infinite distance; that is to say, it unites upon the retina parallel rays of light.

2. The short-sighted eye has, in consequence of an extension of its axis, a stronger refraction, and unites, therefore, in front of the retina the rays of light which proceed from infinite distance. In order to be united upon the retina itself, the rays of light must be divergent; that is to say, they must come from a nearer point. The more short-sighted the eye is, the stronger must be the divergence; such an eye, in order to see distinctly distant objects, must make the rays from a distant object more divergent, by aid of a concave glass. We determine the degree of short-sightedness by the power of the weakest concave glass that enables the eye to see distinctly at a great distance.

3. The over-sighted, or hypermetropic eye, on the contrary, has too weak a refraction: it unites convergent rays of light upon the retina; parallel or divergent rays of light it unites behind the retina, unless an effort of accommodation is made. The degree of hypermetropy, or over-sightedness, is determined by the focal distance of the strongest convex glass with which objects can still be distinctly seen at a great distance.

Hypermetropy has no essential influence upon painting; it only reduces the power of application, and must therefore be corrected by wearing convex glasses. This can never be avoided if the hypermetropy is so great as to diminish the distinctness of vision. Short-sightedness, on the contrary, generally influences the choice of the subject of the artist and also the manner of its execution. As a very small handwriting is an indication of short-sightedness, so we find that artists who paint small pictures, and finish the details with great minuteness, and with fine touches of the brush, are mostly short-sighted.

Sometimes the shape of the eye diverges from its normal spherical form, and this is called astigmatism. This has only been closely investigated since Airy discovered it in his own eye. Figure to yourself meridians drawn on the eye as on a globe, so that one pole is placed in front: then you can define astigmatism as a difference in the curvature of two meridians, which may, for instance, stand perpendicularly upon each other; the consequence of which is a difference in the power of refraction of the eye in the direction of the two meridians. An eye may,

for instance, have a normal refraction in its horizontal meridian, and be short-sighted in its vertical meridian. Small differences of this kind are found in almost every eye, but are not perceived. Higher degrees of astigmatism, which decidedly disturb vision, are, however, not uncommon, and are, therefore, also found among painters. I have had occasion to examine the eyes of several distinguished artists which presented such an anomaly, and it interested me much to discover what influence this defect had upon their works. The diversity depends in part upon the degree and nature of the optical anomaly, but its effect shows itself in different ways, according to the subjects the artist paints. An example will explain this better. I know a landscape-painter and a portrait-painter who have both the same kind of astigmatism; that is, the refraction of the vertical meridian differs from the refraction of the horizontal one. The consequence is, that their sight is normal for vertical lines, but for horizontal lines they are

FIG. 1.

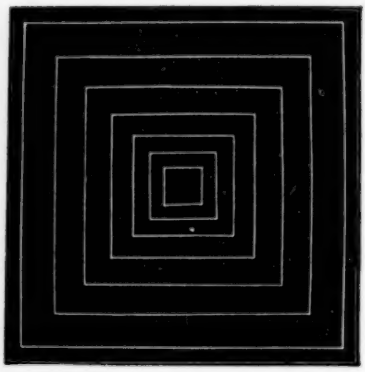
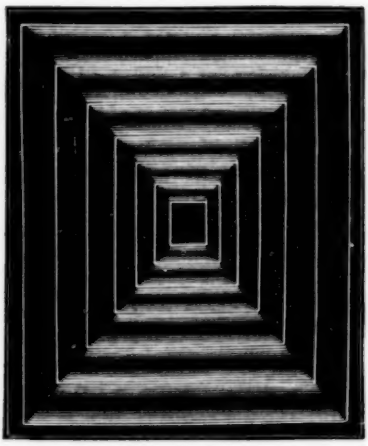


FIG. 2.



slightly short-sighted. Upon the landscape-painter this has hardly any disturbing influence. In painting distant views, sharp outlines are not requisite, but rather undefined and blending tones of color. His eye is sufficiently normal to see these. I was struck, however, by the fact that the foreground of his pictures, which generally represents water with gently-moving waves, was not painted with the same truthfulness to Nature as the middle and background. There I found short horizontal strokes of the brush in different colors, which did not seem to belong to the water. I therefore examined the picture with a glass, which, when added to my eye, produced the same degree of astigmatism as existed in the painter's eye, and the whole picture appeared much more beautiful, the foreground being now as perfect as the middle and background. In consequence of this artificially-produced astigmatism, I saw the horizontal strokes of the brush indistinctly,

and so mixed together that through them the color and transparency of the water were most exquisitely rendered.

Upon the portrait-painter astigmatism had a very different influence. He was held in high esteem in Paris, on account of his excellent grasp of character and intellectual individuality. His admirers considered even the material resemblance of his portraits as perfect; most people, however, thought he had intentionally neglected the material likeness by rendering in an indistinct and vague manner the details of the features and the forms. A careful analysis of the picture shows that this indistinctness was not at all intentional, but simply the consequence of astigmatism. Within the last few years, the portraits of this painter have become considerably worse, because the former indistinctness has grown into positively false proportions. The neck and oval of the face appear in all his portraits considerably elongated, and all details are in the same manner distorted. What is the cause

FIG. 3.

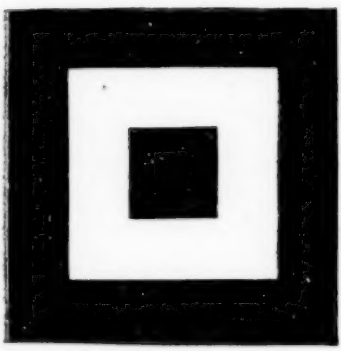
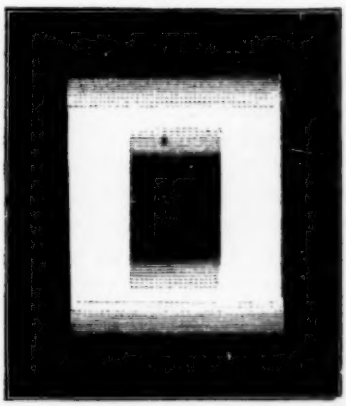


FIG. 4.



of this? Has the degree of his astigmatism increased? No; this does not often happen: but the effect of astigmatism has doubled, and this has happened in the following manner: An eye which is normal as regards the vision of vertical lines, but short-sighted for horizontal lines, sees the objects elongated in a vertical direction. When the time of life arrives that the normal eye becomes far-sighted, but not yet the short-sighted eye, this astigmatic eye will at short distance see the vertical lines indistinctly, but horizontal lines still distinctly; and, therefore, near objects will be elongated in an horizontal direction. The portrait-painter, in whom a slight degree of astigmatism manifested itself at first only by the indistinctness of the horizontal lines, has now become far-sighted for vertical lines, and therefore sees a distant person elongated in a vertical direction; his picture, on the contrary, being at a short distance, is seen by him enlarged in an horizontal direction, and is thus painted still more elongated than the subject is

seen: so the fault is doubled. I shall be able to show this more clearly by experiments.

The vertical and horizontal lines of the diagram (Fig. 1) are reflected with equal distinctness upon the screen by the spherical apparatus.

Those among my audience who have a decided form of astigmatism will, nevertheless, see them differently. Those whose sight is normal will only observe a difference after I have added a cylindrical lens to this apparatus, and thus made it astigmatical (Fig. 2). Ordinary spectacle-glasses are worked by a rotating movement on the surface of a sphere; cylindrical lenses are worked by moving the glass backward and forward upon a cylindrical surface. Such glasses produce an optical effect only in one direction. If instead of white lines I make the experiment with colored lines, it will show the mixing of colors produced by astigmatism; and if I now turn the axis of the lens, you will observe the effect of different forms of astigmatism. I show you a square (Fig. 3): if I add a cylindrical concave glass, with its axis placed horizontally, the square becomes an oblong.

In order now to show you how it is possible that the same eye may see an object at too great a distance elongated in a vertical direction, and, on the contrary, one that is too near enlarged in an horizontal direction, I need only place this cylindrical glass before or behind the focus of the apparatus without turning the axis, and you will then see the square, first elongated in a vertical direction (Fig. 4), and then enlarged in an horizontal direction.

Lastly, I show you a portrait. Imagine to yourself that it represents the person whom the astigmatical painter is painting; then, by aid of the cylindrical glass, you can form an idea how the painter sees this person.

If I alter the position of the glass, the portrait assumes the form in which the painter sees his own painting on the canvas. This will explain to you why he paints the portrait still longer than he sees the person.

With regard to an anomaly of sight, which seems almost foreign to the subject of painting—I mean color-blindness—I will also say a few words here, as the subject seems to be regarded with particular interest in England.

What we call color-blindness is a congenital defect of vision, which is characterized by the absence of one of the three primary sensations of color. The primary sensations of color are red, green, and violet, according to Thomas Young and Helmholtz; or red, green, and blue, according to Maxwell. When, as may easily happen, to this defect is joined a decided talent for painting, drawing alone ought to be attempted, because so absolute a defect will soon assert itself. But we meet with slighter degrees of color-blindness, where the perception of red is not entirely wanting, but only considerably diminished; so

that, for instance, an intense or strongly illuminated red can be perceived as such, while a less intense red appears green. This moderate degree of color-blindness does not always deter people from painting. A proof of this I saw at the last year's Exhibition, in a picture which represented a cattle-market. The roofs of the surrounding houses were all painted red on the sunny side, green in the shadow; but—what particularly struck me—the oxen also were red in the sun, green in the shadow. The slighter degrees of this anomaly, in the form of an insufficient perception of colors, have probably been the real cause why several great artists, who have become famous on account of the beauty of their drawing and the richness of their compositions, have failed to attain an equal degree of perfection in coloring.

In opposition to these isolated cases, I have to draw your attention to other cases which happen more frequently, and in advanced age, in consequence of a change in the perception of colors. They do not arise from a deficient function of the nervous apparatus of the eye, but in consequence of a change in the color of the lens.

The lens always gets rather yellow at an advanced age, and with many people the intensity of the discoloration is considerable. This, however, does not essentially diminish the power of vision. In order to get a distinct idea of the effect of this discoloration, it is best to make experiments with yellow glasses of the corresponding shade. Only, the experiment must be continued for some time, because at first every thing looks yellow to us. But the eye gets soon accustomed to the color, or rather it becomes dulled with regard to it, and then things appear again in their true light and color. This is at least the case with all objects of a somewhat bright and deep color. A careful examination, however, shows that a pale blue, or rather a certain small quantity of blue, cannot be perceived even after a very prolonged experiment, and after the eye has long got accustomed to the yellow color, because the yellow glass really excludes it. This must, of course, exercise a considerable influence when looking at pictures, on account of the great difference which necessarily exists between real objects and their representation in pictures.

These differences are many and great, as has been so thoroughly explained by Helmholtz. Let us for a moment waive the consideration of the difference produced by transmitting an object seen as a body on to a simple flat surface, and consider only the intensity of light and color. The intensity of light proceeding from the sun and reflected by objects is so infinitely greater than the strongest light reflected from a picture, that the proportion expressed in numbers is far beyond our comprehension. There is also so great a difference between the color of light, or of an illuminated object, and the pigments employed in painting, that it appears wonderful that the art of painting can, by the use of them, produce such perfect optical delusions. It can, of course, only produce optical delusions, never a real optical

identity; that is to say, the image which is traced in our eye by real objects is not identical with the image produced in our eye by the picture. This is best observed by changing the light. Whoever paints in London has but too frequent opportunities of observing this. A little more or less fog, the reflection of a cloud, illuminated by the sun, suffices to alter entirely the coloring of the picture, while the coloring of natural objects is not changed in the same manner.

Let us now return to our experiment with the yellow glass, and we shall find that it affects our eye very much in the same way as a yellow tint in the light, and therefore modifies natural objects in quite a different degree from pictures. If we continue the experiment for a considerable time, the difference becomes more and more essential. As I said before, the eye becomes dulled with regard to the yellow light, and thus sees Nature again in its normal coloring. The small quantity of blue light which is excluded by the yellow glass produces no sensible difference, as the difference is equalized by a diminution of sensibility with regard to yellow. In the picture, on the contrary, there is found in many places only as much blue as is perfectly absorbed by the yellow glass, and this, therefore, can never be perceived, however long we continue the experiment. Even for those parts of the picture which have been painted with the most intense blue the painter could produce, the quantity of blue excluded by the yellow glass will make itself felt, because its power is not so small with regard to pigments as with regard to the blue in Nature.

Imagine, now, that, in the course of years, one of the transparent media in the eye of a painter had gradually become yellowish, and that this yellow had by degrees considerably increased in intensity, and you will easily understand the influence it must exercise upon his work. He will see in Nature almost every thing correctly; but in his picture every thing will appear to him yellowish, and consequently he will paint it too blue. Does he not perceive this himself? Does he not believe it if told of it? Were this the case, it would be easy for him to correct the fault, since an artist can paint in a yellower or bluer tone, as he chooses. These are two questions which are easily answered by psychological experience. He does not perceive it himself, because he does not remember that he formerly saw in a different way. Our remembrance with regard to opinions, sensations, perceptions, etc., which have become gradually modified in the course of years—not by any external influence or sudden impression, but by a gradual change in our own physical or mental individuality—is almost *nil*.

He does not believe it—I would not say because an artist rarely recognizes what others tell him with regard to his works, but because with him, as with every one else, the impressions received through his own eye have a stronger power of conviction than any thing else. "Sehen geht vor Sagen" ("Seeing is believing"), says the old adage.

We are almost always conscious of *indistinct* vision, be it in consequence of incorrect accommodation or insufficient power of sight, especially if it is not congenital, but has gradually appeared. But it is extremely difficult and in many cases impossible to convince those of their defect who suffer from *incorrect* vision as to form and color. They never become conscious of it themselves, even if it is not congenital, and the most enlightened and intelligent among them remain incredulous, or become even angry and offended, when told of it. Incorrect perception of form may, however, easily be demonstrated. If in consequence of astigmatism a square appears oblong to any one, he can measure the sides with a compass; or, what is more simple still, he can turn it so that the horizontal lines are changed into vertical ones, and *vice versa*, and his own sight will convince him of his error. It is more difficult to demonstrate whether a person sees colors correctly or not. Such glaring mistakes as those produced by color-blindness can be easily recognized, but faults produced by a diminished sensation of small differences in the shades of color can only be recognized as such by the fact that the majority of persons with normal vision declare them to be faults. Such, for instance, are deviations produced by an incorrect perception of pigments, which in painting makes itself felt by a constantly-recurring *plus* or *minus* of a single color in the whole picture. It may also show itself by small faults in the rendering of every color. In discussing this subject with artists, they at once declare these anomalies to represent a school, a taste, a manner, which may be arbitrarily changed. They most unwillingly concede that peculiarities of sight have any thing to do with it. It seems to me sometimes as if they considered it in a certain measure a degradation of their art that it should be influenced by an organ of sense, and not depend entirely upon free choice, intelligence, imagination, and talent.

Thus, to return to the point from which we started: if a painter whose lens becomes yellower begins to paint in a bluer tone, it is said that he has changed his style. The painter himself vehemently protests against this opinion; he thinks that he still paints in his old style, and that he has only improved the tone of his color. His earlier works appear to him too brown. To convince him of his error, it would be necessary to remove his lens suddenly. Then every thing would appear to him too blue, and his paintings far too blue. This is no hypothesis, but a fact. Patients on whom I have operated for cataract, very often spontaneously declared, immediately after the operation, that they saw every thing blue; in these cases I invariably found their crystalline lens to be of an intense yellow color. In pictures painted after the artists were considerably over sixty, the effect of the yellow lens can often be studied. To me their pictures have so characteristic a tone of color, that I could easily point them out while passing through a picture-gallery. As a striking example,

I will only mention Mulready. It is generally stated that in his advanced age he painted too purple. A careful examination shows that the peculiarity of the colors of his later pictures is produced by an addition of blue. Thus, for instance, the shadows on the flesh are painted in pure ultramarine. Blue drapery he painted most unnaturally blue. Red of course became purple. If you look at these pictures through a yellow glass, all these faults disappear: what formerly appeared unnatural and displeasing is at once corrected; the violet color of the face shows a natural red; the blue shades become gray; the unnatural glaring blue of the drapery is softened. To make the correction perfect, the glass must not be of a bright gold-color, but rather of the color of pale sherry. It must be gradually darkened in accordance with the advancing age of the painter, and will then correspond exactly with the color of his lens. The best proof of the correctness of this statement is, that the yellow glass not only modifies the blue in Mulready's pictures, but gives truthfulness to all the other colors he employed. To make the proof complete, it would be necessary to show that by the aid of yellow glass we saw Mulready's pictures as he saw them with the naked eye; and this can be proved. It happens that Mulready has painted the same subject twice—first in 1836, when he was 50 years of age and his lens was in a normal state, and again in 1857, when he was 71, and the yellow discoloration had considerably advanced. The first picture was called "Brother and Sister; or Pinching the Ear;" the second was called "The Young Brother." In both pictures a girl, whose back only is visible, is carrying a little child. A young peasant, in a blue smock-frock, stands to the right and seizes the ear of the child. The background is formed by a cloudy sky and part of a tree. Both pictures are in the Kensington Museum. The identity of the composition makes the difference in the coloring more striking. If we look at the second picture through a yellow glass, the difference between the two almost entirely disappears, as the glass corrects the faults of the picture. The smock-frock of the boy no longer appears of that intense blue which we may see in a lady's silk dress, but never in the smock-frock of a peasant. It changes into the natural tint which we find in the first picture. The purple face of the boy also becomes of a natural color. The shades on the neck of the girl and the arms of the child, which are painted in a pure blue, look now gray, and so do the blue shadows in the clouds. The gray trunk of the tree becomes brown. Surprising is the effect upon the yellowish-green foliage, which, instead of appearing still more yellow, is restored to its natural color, and shows the same tone of color as the foliage in the earlier picture. This last fact is most important to prove the correctness of my supposition. My endeavor to explain it became the starting-point of a series of investigations to ascertain the optical qualities of the pigments used in painting, and thus to enable us to recognize them by optical contrivances, when the

vision of the naked eye does not suffice to analyze the colors of a picture.

When I had the pleasure of showing this experiment with Mulready's pictures to Prof. Tyndall, he drew my attention to the fact that one single color, namely, the blue of the sky, was not affected by the yellow glass. The blue of the sky was almost the same in both pictures. I could not at once explain the cause of this, but I discovered it afterward. The fact is, it is impossible to change the sky-blue of the first picture so as to form a color that looks like it when seen through a yellow glass. If more white is added, the sky becomes too pale; if a deeper blue is used, it becomes too dark. Mulready was thus forced to content himself by giving to the sky in his later pictures the same color as in the earlier ones.

If we look at Mulready's earlier works through the same yellow glass, they lose considerably in beauty of coloring: the tone appears too weak; the shadows brown; the green, dark and colorless; we see them as he saw them, and understand why he became dissatisfied with them and changed his coloring.

It would be more important to correct the abnormal vision of the artist, than to make a normal eye see as the artist saw when his sight had suffered. This, unfortunately, can only be done to a certain extent.

If it is the dispersion of light which, as in Turner's case, alters the perception of Nature, it can be partly rectified by a kind of diaphragm with a small opening (Donders's sthenopeical spectacles).

In cases of astigmatism, the use of cylindrical glasses will completely correct the aspect of Nature, as well as of the picture. Certain anomalies in the sensation of color may also be counteracted to some extent by the use of colored glasses; for instance, by a blue glass, when the lens has become yellow, as in Mulready's case.

If science aims at proving that certain works of art offend against physiological laws, artists and art-critics ought not to think that, by being subjected to the material analysis of physiological investigation, that which is noble, beautiful, and purely intellectual, will be dragged into the dust. They ought, on the contrary, to make the results of these investigations their own. In this way art-critics will often obtain an explanation of the development of the artist, while artists will avoid the inward struggles and disappointments which often arise through the difference between their own perceptions and those of the majority of the public. Never will science be an impediment to the creations of genius.—*Macmillan's Magazine.*

DARWINISM AND DIVINITY.

By L. S.

WE are going through that change in regard to Mr. Darwin's speculations which has occurred so often in regard to scientific theories. When first propounded, divines regarded them with horror, and declared them to be radically opposed not only to the book of Genesis, but to all the religious beliefs which elevate us above the brutes. The opinions have gained wider acceptance; and, whatever may be the ultimate verdict as to their soundness, it certainly cannot be doubted that they are destined profoundly to modify the future current of thought. As Darwinism has won its way to respectability, as it has ceased to be the rash conjecture of some hasty speculator, and is received with all the honors of grave scientific discussion, divines have naturally come to look upon it with different eyes. They have gradually sidled up toward the object which at first struck them as so dark and portentous a phenomenon, and discovered that after all it is not of so diabolic a nature as they had imagined. Its breath does not wither up every lofty aspiration, and every worthy conception of the destiny of humanity. Darwinists are not necessarily hoofed and horned monsters, but are occasionally of pacific habits, and may even be detected in the act of going to church. Room may be made for their tenets alongside of the Thirty-nine Articles, by a little judicious crowding and rearrangement. Some of the old literal interpretations of the Scriptures must perhaps be abandoned, but after all they were in far too precarious a position already to be worth much lamentation. It would be entirely unfair to accuse persons, who have gone through this change, of the smallest conscious insincerity. They are not merely endeavoring to curry favor with an adversary because he has become too formidable to be openly encountered. They have simply found out, in all honesty and sincerity, that the object of their terror has been invested with half his terrible attributes by their own hasty imagination. They are exemplifying once more the truth conveyed in an old story. A man hangs on to the edge of a precipice through the dark hours of the night, believing that if his grasp fails him he will be instantly dashed to a thousand fragments; at length his strength will bear it no longer, and he falls—only to discover that his feet had been all the time within a couple of inches of the ground! The precipice was a creation of his fancy, and the long agony entirely thrown away. So we may believe that a good many sound divines have resigned themselves to the inevitable plunge, and are astonished to find all their vital functions continuing to operate pretty nearly as well after as before the catastrophe. Perhaps they feel rather foolish, though of course they do not say so. One could wish,

certainly, that under these circumstances they would betray a little less uneasiness; and that the discovery that the doctrine is harmless might precede by a rather longer interval the admission that it is true. There would be less room for unkindly cavils. However, it is being discovered, in one way or other, that religion is really not interested in these discussions. We have lately seen, for example, in a very orthodox Romanist organ, that theology has nothing, or next to nothing, to say to Mr. Darwin's theories. It is permissible to believe either that man was made by a single act of the creative energy, or that a pair of apes was selected and improved gradually into humanity, as, if the comparison be admissible, human processes may gradually form the carrier-pigeon out of his wild congeners. We must, indeed, hold that the operation was miraculous; and as the tendency of scientific inquiry is to banish the miraculous, we may say that there is still a fundamental opposition between the teaching of the Church and Mr. Darwin. When we consider how easily the word "miraculous" may itself be rarefied until no particular meaning is left, we may doubt whether this opposition may not be removed; the verdict of science as to the mode in which the phenomena succeeded each other might be accepted, though there would be a difference of opinion as to the efficient cause of the change, and thus a kind of compromise might be effected between the rival forces.

Meanwhile, whatever the validity of this and similar artifices, it may be worth while to consider a little more closely what is the prospect before us. Let us suppose that Darwinism is triumphant at every point. Imagine it to be demonstrated that the long line of our genealogy can be traced back to the lowest organisms; suppose that our descent from the ape is conclusively proved, and the ape's descent from the tidal animal, and the tidal animal's descent from some ultimate monad, in whom all the vital functions are reduced to the merest rudiments. Or, if we will, let us suppose that a still further step has been taken, and the origin of life itself discovered, so that, by putting a certain mixture in an hermetically-sealed bottle, we can create our own ancestors over again. When we endeavor firmly to grasp that conception, we are, of course, sensible of a certain shock. We have a prejudice or two derived from the Zoological Gardens and elsewhere, which, as it were, causes our gorge to rise; but when we have fairly allowed the conception to sink into our minds, when we have brought our other theories into harmony with it, and have lost that uncomfortable sense of friction and distortion which is always produced by the intrusion of a new set of ideas, what is the final result of it all? What is it that we have lost, and what have we acquired in its place? It is surely worth while to face the question boldly, and look into the worst fears that can be conjured up by these terrible discoverers. Probably, after such an inspection, the thought that will occur to any reasonable man will be: What does it matter? What possible difference can it

make to me whether I am sprung from an ape or an angel? The one main fact is that, somehow or other, I am here. How I came here may be a very interesting question to speculative persons, but my thoughts and sensations and faculties are the same on any hypothesis. Sunlight is just as bright if the sun was once a nebulous mass. The convenience of our arms and legs is not in the slightest degree affected by the consideration that our great-great-grandfathers were nothing better than more or less movable stomachs. The poet's imagination and the philosopher's reason are none the worse because the only sign of life given by their ancestors was some sort of vague contractility in a shapeless jelly. Our own personal history, if we choose to trace it far enough back, has taken us through a series of changes almost equally extensive, and we do not think any the worse of ourselves on that account. Our affections and our intellectual faculties are in existence. They are the primary data of the problem, and as long as we are conscious of their existence we need not worry ourselves by asking whether they began to exist by some abrupt change or gradually rose into existence through a series of changes. There is still quite as much room as ever for the loftiest dreams that visit the imaginations of saints or poets. The mode in which we express ourselves must, of course, be slightly altered; but, so long as the same instincts exist which sought gratification in the old language, we need not doubt but they will frame a new one out of the changed materials of thought. The fact that religion exists is sufficient demonstration that men feel the need of loving each other, of elevating the future and the past above the present, of rising above the purely sensual wants of our nature, and so on; the need will exist just as much, whether we take one view or other of a set of facts which, on any hypothesis, happened many thousands of years before we were born, and in regard to which a contented ignorance is far from being an impossible frame of mind. One can understand, after a little trouble, how it was that at a particular period of history people fancied that disinterested love would leave the world, and a moral chaos be produced, if it should be made to appear that it was not literally true that we are all descended from a man who was turned out of a garden for eating an apple. The infidels who assailed, and the orthodox who defended that dogma, really believed that it was an essential cornerstone in the foundations of all religion, which, once removed, nothing but a universal crash could follow. Even the statement that it might possibly be an allegory instead of an historical record nearly frightened our prosaic ancestors out of their wits. Remove one brick from the cunningly-adjusted fabric of orthodoxy, prove that a line of the Hebrew Scriptures was erroneous, and God would vanish from the world, heaven and hell become empty names, all motives for doing good be removed, and the earth become a blank and dreary wilderness. In remote country towns and small clerical coteries some vestiges of

this cheerful opinion still linger. Most men have grown beyond it, and have found some broader basis for their hopes and aspirations. And yet, when one comes to think about it, is not the alarm which has been caused by the statement that Adam was the great-grandson of an ape equally preposterous? Why should it have so fluttered the dove-cotes of the Church? If science could have proved divines to be apes themselves, there would have been some ground for vexation; but that was obviously out of the question, and their alarm would only prove that they were drawing some very unwarrantable inferences, or else by association of ideas had become unable to distinguish between the essence and the remotest accidental accompaniments of the faith. What interest can the highest part of our nature really take in a dispute as to whether certain facts did or did not occur many ages ago? The *prima-facie* presumption is, certainly, that any change in our opinions would affect rather the external imagery than the faith which it embodies. One would say at first sight that religion is no more likely to leave the world because we have new views as to the mode in which the world began, than poetry to vanish as soon as we have ceased to believe in the historical accuracy of the account of the siege of Troy. Man possesses certain spiritual organs, whose function it is to produce religion. Religion could only be destroyed by removing the organs, and not by supplying them with slightly different food.

The precise nature of the fears entertained by the orthodox is revealed by the arguments generally brought to bear against the new doctrine. There is, for example, what may be called the metaphysical argument, which, in one form or another, seems to be regarded as important. It is substantially an attempt to prove that the gap between the brute and the human mind is so wide that we cannot imagine it to be filled up by any continuous series. It is argued at great length that instinct differs from reason not in degree but in kind, or that brutes do not possess even the rudiments of what we call a moral sense. The argument has long been more or less familiar. Animals have always been regarded with a certain dislike by theological arrogance. It has been held to be a conclusive objection to the validity of certain arguments for the immortality of the soul, that they would open the path to heaven to our dogs as well as to ourselves. It does not seem very easy to give any satisfactory reason for the extreme abhorrence with which such a consummation is regarded, or to say why we should claim a monopoly in another world which we do not enjoy in this. Philosophers, indeed, have gone further, and denied to animals even the most moderate share of our own capacities, and have set them down as nothing better than machines. One is really rather glad to see the poor beasts getting their revenge in public opinion, and being recognized as our relations after having been almost repudiated as fellow-creatures. The distinctions, indeed, which have

been drawn seem to us to rest upon no better foundation than a great many other metaphysical distinctions: that is, the assumption that, because you can give two things different names, they must therefore have different natures. It is difficult to understand how anybody who has ever kept a dog, or seen an elephant, can have any doubts as to an animal's power of performing the essential processes of reasoning. We have been saying in thousands of treatises on logic, All men are mortal: Socrates is a man, therefore Socrates is mortal. The elephant reasons: All boys are bun-giving animals; that biped is a boy; therefore I will hold out my trunk to him. A philosopher says, The barometer is rising, and therefore we shall have fine weather; his dog says, My master is putting on his hat, and therefore I am going to have a walk. A dog equals a detective in the sharpness with which he infers general objectionableness from ragged clothes. A clever dog draws more refined inferences. If he is not up to enough simple arithmetic to count seven, he can at least say, Everybody is looking so gloomy that it must be Sunday morning. If he is a sheep-dog, he is probably more capable of finding his way over hills than most members of the Alpine Club, and capable of combining his actions with a view to making the sheep—whose reasoning powers are limited—follow the right track. He can found judgments on cautious experiment, as anybody will admit who has seen a dog testing the strength of a plank which he has to cross, or measuring the height of a jump. In fact, a dog is constantly performing rudimentary acts of reason, which can only be distinguished from our own by the fact that he cannot put them into words. He can understand a few simple words; and, though he cannot articulate, he can make sounds indicative of his wants and emotions, which are to words what the embryo is to the perfect organism. He cannot put together a sentence; but to found a distinction of kind between his intellectual performances and those of man upon that circumstance, seems to be as unreasonable as to make a similar distinction between the intellect of the savage who cannot count five, and that of the philosopher who can use mathematical symbols. The power of abstraction has been carried a step, and a very important step, farther in each case; but there is no more cause to suspect the introduction of an entirely new element in one case than the other.

The condemnation of the poor brutes as non-moral (if we may use such a word) seems to be still more monstrous. We need not speak of exceptional stories, such as the legend in a recent French newspaper of the sensitive dog who committed suicide when deserted by his friends; but who can doubt that his dog has something which serves as a very fair substitute for a sense of duty? Could any thing be more like human heroism than the conduct of the poor collie who drove home her master's sheep, leaving her new-born puppies by the side of the road? Or, to avoid particular instances, is there a barris-

ter in England who can blush half so expressively as a dog found out in sharp practice—blushing, of course, being taken in a sense applicable to the dog's tail? Whether wild animals have such a sense of the value of any positive laws is more than we know; but wild animals, down to the lowest orders, show at least the maternal instinct. The devotion of beasts to their young belongs, one would say, to the highest order of moral beauty—except that it extends too low down among animated beings to please some people. Yet we may presume that the most hard-hearted of metaphysicians would find it hard to suppress an emotion of sympathy and approval at the sight of a bird overcoming its timidity to fight for its little puff-balls of children. It is a more pathetic if not a more sublime sight than those starry heavens with which we are so often bored. There is a bit of metaphysical quibbling, by which it is endeavored to evade the obvious inference. It seems to come to this, when analyzed, that, though the bird performs an heroic action, it has never framed the general proposition, Mothers ought to love their young. That is undeniable; but surely the bird is on the high-road to it. Light up its feeble brain with a little more intelligence, and it will have no trouble in fitting its instincts with the proper strait-waistcoats of formula. To deny virtue to the bird would be to deny it equally to the savage, who has movements of generosity and self-devotion, though it has never occurred to him to speculate on moral philosophy. There is, of course, a difference between the virtue which merely results from the spontaneous play of unselfish instincts, and that which includes a certain list of definite propositions on the subject formed by reflection and observation. But where the first is present, even in a high degree, it is not difficult to account for the gradual development of the second.

The argument, however, has another fatal weakness, if it is intended to raise a presumption against the possible passage from apehood to manhood. Assume, if you please, that the difference is as wide as possible. Suppose that reason and the moral sense are as different from the rudimentary thoughts and passions that animate the feeble brute-brain as water from fire or as mind from matter. That will not raise any presumption that there must be a sudden gap in the chain of animated beings, unless you can prove that the new element, whatever it may be called, must enter, as it were, at one bound. If reason be radically different from instinct, yet reason may be present in some creatures in a merely rudimentary form. The question, indeed, does not admit of argument. We always have before our eyes a perfect and uninterrupted series. The child of six months old is less intelligent than a full-grown dog; and if we would imagine the development of man from monkey, we have only to suppose the first monkey to be the equal of an average baby (say) of one year old, the monkey's son to be equal to a baby of a year and a day, and so on. We may thus proceed by perfectly imperceptible stages, and in the course of three

or four thousand generations we shall get a man-monkey fully equal in intelligence to the average Hottentot. Thence upward we cannot deny the possibility of development without heterodoxy. In short, by interpolating a sufficient number of terms we may form an ideal, which, for any thing we can say, may be an actual series ending with the man and beginning with the inferior animals, in which there shall not be a single violent transition. The question whether reason is or is not specially distinct from instinct is simply irrelevant. In one case we must suppose that it begins by entering in homœopathic doses; in the other, that it is simply the development of certain lower faculties; in either case the animal will shade into the human intellect by degrees as imperceptible as those by which night changes into dawn. Indeed, it is impossible to see why—except from fear of certain conclusions, which is not a logical ground for dissent—the possibility of a passage from brute to man should ever have been denied on *a priori* grounds. Whether the theory is confirmed or confuted by observation is an entirely open question; but it is strange that it should be pronounced impossible when we are ready to admit infinitely greater changes. If you can imagine a monkey to have been developed from a sea-anemone, an animal from a plant, or living from inorganic matter—and none of these changes, however little reason we have to believe in their actual occurrence, are supposed to be obnoxious to any insurmountable objection *a priori*—why can we not admit that a monkey may possibly become a man?

It is here that we come upon the confusion already noticed. It results from mixing metaphysical inquiries about the what? with scientific inquiries into the how? A man of science says (possibly he makes a mistake, but that is not to the purpose), Mix such and such elements under such and such conditions, and a living organism will make its appearance. The theologian sometimes meets this statement as if it were equivalent to an assertion that life is nothing but an arrangement of matter. He has really said nothing of the kind: he does not know what is the essence of life or of matter; he has merely to do with the order in which phenomena occur; and has absolutely no concern with the occult substratum in which they are supposed to inhere. The utmost that he can ever say—if he can ever say so much—would come to this: Bring together a set of the phenomena which we call molecules, and there will result a series of the phenomena which we call vital; but what molecules are, or what life is, is a question beyond his competence. Similarly, when he proceeds a step farther and traces the origin of our moral sense to some dumb instinct in the animal world, he is not really speaking treason against the dignity and importance of morality. Mr. Browning, in one of his poems, speaks of some contemptible French author who explained the origin of modesty by referring, as only a very free-speaking person could refer, to the mode in which the sexual instinct operated upon savage

natures. If that Frenchman meant to infer that the modesty of a civilized being is no better than the semi-bestial instincts of a man-ape, he was as contemptible as the poet could wish, but he was also grossly illogical. His observation merely went to show by what means one of the most essential of social instincts was originally generated in the world; and it is not the less essential because in its first origin it partook of the grossness of the animal in which it was implanted. Mr. MacLennan has written a very interesting book tending to show that the original marriage ceremony was everywhere like that which survives in Australia to this day, where the wild human being knocks down his beloved with a club, and drags her off to his own den. Suppose this to be true, would it follow that marriage in the most refined and purest societies was no better than forcible abduction as practised in the Australian bush? Surely it would follow no more than the development of a man from a monkey would prove that men still have tails, or that the brain of a Newton is no better than that which directs a chimpanzee in its search for nuts. In short, it is sufficiently plain that we do not diminish the value of any human accomplishments by tracing them back to their remote origin in the brute, or even the insect creation. That shudder which runs through us when we are invited to recognize our poor relations in the Regent's Park is gratuitous. The philosopher may have thrown more light upon the process by which we came to be what we are; but he does not, for he obviously cannot, argue that we are other than we are. Whether in pursuing our genealogy we stop short at "who was the son of Adam," or carry it back through a vast series of links to "who was the son of a monkey," the fact of our present existence, with our present instincts, aspirations, and endowments, remains precisely what it was. The prospect, indeed, is improved for our remote descendants, "far on in summers that we shall not see;" but for us poor creatures living and moving in this nineteenth century after Christ, the circumstances remain unaltered. Turn it as you will, we are the base from which the line is measured, and not the indeterminate point to be discovered by a process of trigonometry.

Is, then, the alarm which has been excited in men's minds totally unreasonable? In one sense it would seem to be so. The speculations of which we have been speaking are absolutely harmless to any one who holds—as surely every sincere believer ought to hold—that religion depends upon certain instincts whose existence cannot be explained away by any possible account of the mode by which they came into existence. Property is not less sacred in the eyes of a reasonable man because it may have originated in mere physical force; nor religion because it first dawned upon mankind in the vague guesses of some torpid brain, which fancied that a bigger Caliban was moving the stars and rolling the thunder. But it may be true that the new theories will transform the mode in which men interpret the universe to themselves,

and will therefore destroy some of the old formulæ which involved different perceptions. To those who have succeeded in persuading themselves that any set of Articles constructed some centuries ago were to be final and indestructible expressions of truth, the prospect may certainly be distressing. There may, indeed, be no positive logical irreconcilability between orthodoxy and Darwinism. A little more straining of a few phrases which have proved themselves to be sufficiently elastic, and the first obvious difficulty may be removed. The first chapter of Genesis has survived Sir Charles Lyell; it may be stretched sufficiently to include Mr. Darwin. But in questions of this kind there is a kind of logical instinct which outruns the immediate application of the new theories. The mere change of perspective does much. When the sun was finally placed in the centre of the heavens instead of the earth, the few texts which apparently opposed were easily adapted to the new theories. But there was a further change of infinitely greater importance, which, though not so easily embodied in direct logical issues, profoundly modified all theological conceptions. When people began to realize the fact that we live in a wretched little atom of a planet dancing about the sun, instead of being the whole universe, with a few stars to save candle-light, the ancient orthodoxy was shaken to its base. It is impossible to read the controversies which marked the great intellectual revolt of the last century without seeing how much men's minds were influenced by the simple consideration that Christians were a small numerical minority of the human race, and the habitation of the race a mere grain of dust in the universe. The facts were more or less known before, and were not capable of furnishing syllogisms absolutely incompatible with any orthodox dogma. And yet the mere change in the point of view, working rather upon the imagination than the reason, gradually made the old positions untenable. A similar change is being brought about by the application of that method of which Darwinism is at present the most conspicuous example. Possibly the change may be of even greater importance. Certainly it is of far too great importance to be more than dimly indicated here. Briefly it may be described as the substitution of a belief in gradual evolution for a belief in spasmodic action and occasional outbursts of creative energy; of the acceptance of the corollary that we must seek for the explanation of facts or ideas by tracing their history instead of accounting for them by some short *a priori* method; and thus of the adoption of the historical method in all manner of investigations into social, and political, and religious problems which were formerly solved by a much more summary, if not more satisfactory method.

It is curious to remark how the influence of new methods penetrates the minds of those who would most strenuously repudiate some of the results to which they lead. We may illustrate the point by an analogy drawn from the theory of which we have been speaking. Mr. Wal-

lace has described what he calls protective resemblances. A butterfly which precisely suits the palates of certain birds would be speedily exterminated if it were not for an ingenious device. It cleverly passes itself off under false colors by imitating the external shape of some other butterfly, which the bird considers as disgusting. So oysters, if they were quick enough, might evade the onslaught of human appetites by taking the external resemblance of periwinkles. A very similar variety of protective resemblance may be detected in the history of opinions. The old-fashioned doctrine remains essentially the same, but it changes its phraseology so as to look exactly like its intrusive rival. We have already given an instance. It is permissible, it appears, for orthodox Catholics to hold that the series of facts alleged by Mr. Darwin actually occurred, and that the ape changed by slow degrees into the man; only they must save themselves by calling the process miraculous, and thus, for a time at least, the old theory may be preserved. Perhaps it will strike people, in the course of years, that if all the phenomena conform to the law established by philosophers, it is rather absurd to say that they do not conform in virtue of the law, but in virtue of a specific interference of Divine power. Still the ingenuity of the artifice is obvious, and it affords an instructive example of the method of reconciling old things and new. In the same way, the theological doctrine of development mimics the historical accounts of the process by which opinions have actually been formed. Just as the skeptic rashly fancies that he has brought matters to a conclusive issue, the theologian evades his grasp by putting on the external form of the very doctrines which he has been opposing.

Thus, for example, Dr. Newman argues in the "Grammar of Assent" for the doctrine of the Atonement, on the ground (among others) that a similar belief is found to exist in all barbarous nations. It may seem strange, he goes on to say, that he should take his ideas of natural religion from the initial and not from the final stage of human development. His "answer is obvious," and it comes shortly to this, that our "so-called civilization" is a one-sided development of man's nature, favoring the intellect, but neglecting the conscience; and that, therefore, it is "no wonder that the religion in which it issues has no sympathy with the hopes and fears of the awakened soul, or with those frightful presentiments which are expressed in the worship and the traditions of the heathen." In simpler times the resemblances between the heathen and the orthodox religion would have been indignantly denied, or regarded as diabolic parodies. Now, the Catholic divine is as ready as the philosopher to trace out the analogy, though he puts a different interpretation upon it. The philosopher, that is, regards the Catholic religion as preserving the remains of older forms of thought which are gradually expiring under the influence of free inquiry. The divine accepts just the same facts, but he regards the old barbarous superstition as a dim reflection of revealed truths, while a satisfactory

reason is found for putting the civilized intellect out of court altogether. The verdict of the stupid, ferocious savage, who makes an idol out of a bit of wood and a red rag, and then pacifies its spite by slaughtering fowls or prisoners in its honor, is not at first sight superior to that of the modern philosopher; but the philosopher is "one-sided." This, however, is beside the point. It is clear that modern tendencies have penetrated into the hostile camp. It is the much-abused philosopher who has taught us to take a new interest in the lower religions of the world instead of summarily rejecting them as the work of devils. The mere fact that we have risen to such a conception as that of a comparative study of religion is certainly not sufficient by itself to confute the pretensions of what claims to be an exclusive revelation. It is possible to adapt the old to the new beliefs by the methods of which Dr. Newman's argument is an example. After Mr. Darwin and his followers have traced out the resemblance between men and monkeys with the utmost possible clearness, it is always possible for a dogmatist to discover some good reason why the transition should have required a miraculous intervention. In the same way, the analogies which the philosopher may discover between the various religions of the world will never convince him that his own special creed is not of supernatural origin, though the others which resemble it so strangely are traceable to the spontaneous working of the human intellect. A very little dexterity is required to raise the resemblance to that point at which it becomes an argument for the reasonableness of the supposed revelation, and is yet no argument against its supernatural character. Admit your naked savage to prove that man has a need for the belief in Atonement, but do not let him be produced as evidence that the belief finds its most congenial element and grows to the largest dimensions in a debased and torpid intellect. By such logical manipulation as this, the accumulation of uncomfortable facts may long be rendered harmless. It all depends upon the way in which you look at things. The acute thinkers who have helped to elaborate any ancient system of thought have always provided a proper set of pigeonholes in which inconvenient facts may be stowed away. It is long before the facts become weighty enough to break down the framework. But no agent is so powerful in bringing about the change as the subtle and penetrating influence of a new method. It may not follow logically that because catastrophes have been banished from geology, and the series of animated beings has been proved to be continuous, therefore the same conceptions should be applied to the religious beliefs of mankind. And yet nobody can doubt that in practice the influence would be unmistakable. The burden of proof would be shifted, and that in itself makes an amazing difference. The popular belief has hitherto been that, unless you could prove the contrary, it would be reasonable to suppose that the transition from monkey to man involved a sudden leap. If it came to be the popular belief that, unless you

could prove the contrary, men must be supposed to have developed out of monkeys by the forces now at work, the imagination would outrun the reason. It would be assumed that a religion was the growth of that stage of development at which the human intellect had arrived, and not the work of a series of sudden interferences. Christianity would be a phenomenon to be studied like others by the investigation of the conditions under which it arose, and the advocates of a theory of supernatural intervention would have to encounter a set of established beliefs instead of finding them in their favor. This is the imperceptible intellectual influence which gradually permeates and transforms the prevalent conceptions by a process which is as irresistible as it is difficult to define by accurate formulæ. Religious instincts, we rightly say, are indestructible; but the forms in which they may be embodied are indefinitely variable, and no one can say how fast and how far the influence of a change worked in one department of thought may gradually spread by a silent contagion to others apparently removed from it.

Thus, admitting to the fullest extent that Darwinism not only does not threaten, but does not even tend to threaten, the really valuable elements of our religious opinions, it is quite consistent to maintain that it may change the conceptions in which they are at present embodied to an extent to which it is impossible to assign any limits. Darwinism, for example, does not make it more difficult to believe in a God. On the contrary, it may be fairly urged that any theory which tends to bring any sort of order out of the confused chaos of facts which we have before us, makes it so far more easy to maintain a rational theism such as is now possible. It helps us to form some dim guess of whence we are coming and of whither we are going—to see, as it were, an arc of the vast orbit in which the world is revolving, instead of being limited to an infinitesimal element, lost at each extremity in hopeless darkness. But it is true that it weakens that conception of the Creator which supposes him to intervene at stated periods, in order to give an impulse to the machinery. How deeply that change may affect all manner of theological conceptions it is unnecessary to consider. There is another doctrine which seems to be more nearly affected; and probably, though we seldom give open expression to our fears, it is this tendency which is really the animating cause of the alarm which is obviously felt. Does not the new theory make it difficult to believe in immortal souls? If we admit that the difference between men and monkeys is merely a difference of degree, can we continue to hold that monkeys will disappear at their death like a bubble, and that men will rise from their ashes? So vast a difference in the ultimate fate and the intrinsic nature of the two links should surely correspond to a wide gap in the chain. We are too proud to admit a gorilla or a chimpanzee to a future world, and yet, if they are only lower forms of humanity, we do not quite see our way to exclude them. The difficulty in one shape or another has long

been felt. "Nobody thinks," says Voltaire, "of giving an immortal soul to a flea; why should you give one any the more to an elephant, or a monkey, or my Champagne valet, or a village steward, who has a trifle more instinct than my valet?" The difficulty of drawing the line is enhanced to the imagination when we assume that the flea is the remote ancestor of the village steward, and believe that one has melted by imperceptible degrees into the other. The orthodox may be excused for trembling when they see that central article of their faith assailed, and are in danger of being deprived of the great consolations of their religion—heaven and hell. It would be preposterous to attempt to argue so vast a question in our space. This much, however, may perhaps be said without offence: Whatever reasons may be drawn from our consciousness for the belief that man is not merely a cunning bit of chemistry—a product of so much oxygen, hydrogen, and carbon—must remain in full force. We may doubt how far the belief ever rested on metaphysical arguments, and, indeed, it seems to be the orthodox opinion that it must be accepted on the strength of revelation. It would therefore only be affected so far as Darwinism and the methods to which it gives rise tend to explain the origin and growth of a faith to which all believers cling so fondly. And, whatever the result may be, it is at least natural to suppose that it would rather tend to modify than to destroy the belief, to set bounds to the dogmatic confidence with which we have ventured to define the nature of the soul than to uproot our belief in its existence. After all, it would not be a very terrible result if we should be driven to the conclusion that some kind of rudimentary soul may be found even in the lower animals. The *Spectator*, which is a very amiable and reasonably orthodox journal, has lately been asking whether we have any excuse for refusing immortality to well-conducted cats, or to that admirable and fortunately authentic dog which watched for ten years upon its master's grave. Poor beast! we should be willing to hope that he has found admission to the equal sky; but without jesting on so awful a subject, or venturing into mysteries where the boldest metaphysician walks with uncertain tread, we would simply say that we can see no reason why our new conceptions of the facts—assuming that they establish themselves—should not be accommodated to a spiritual form of belief. After all, it will be hard to convince men that because thought and feeling arise from certain combinations of matter, therefore they are made of matter. But we pause at the threshold of such speculations.

There is, however, one other thing to be said, and it may be said plainly and without irreverence. After all, why is the belief in immortality so essential to the happiness of mankind? It is not because we, as virtuous people, think it necessary that a place should be provided where the virtuous may receive an interminable pension for their good deeds, and the bad be tormented to the end of time. Some people, it is true, ask for a kind of penal settlement in another world,

in order to save our police-rates in this. But that doctrine, though it has been preached with amazing emphasis, has not been found to be, on the whole, very edifying. It may serve to remind us that even a belief in immortality may be made as degrading as the grossest forms of materialism. It may convert religion into a specially clever form of selfishness, and take the grace out of the Christian character. The persons who call themselves spiritualists in the present day sometimes claim to be providing an excellent substitute for our old superstitions. The objection which one really feels to them is not so much that they are misled by a contemptible juggle, but that they encourage a kind of prurient religiosity which is inexpressibly revolting. What they really try to persuade us is, not that man has a soul which may be elevated far above our earthly wants and longings, but that there is a set of invisible beings who walk about this world playing tricks with tables and talking nonsense, to which the twaddle of the Yankee young ladies in "Martin Chuzzlewit" is refined and elevating. Their so-called spirits are of the earth, earthy; and it would be more satisfactory to believe that at death we became parts of the ocean and the air—that we formed part of the raw material from which, in the course of the ages, new sentient and thinking beings may be evolved, than that we sank into the likeness of a set of stupid hobgoblins, playing conjuring tricks for the amusement of fools. Gross as some such doctrines may be, they may also be cited for another purpose. Men are virtuous, it is sometimes said, because they believe in hell. Is not this an inversion of the proper order of thought? Should we not rather say that men have believed in hell because they were virtuous? There has been so general a belief that vice was degrading, and was to be discouraged by the strongest possible motives, that even the material part of mankind have exhausted their fancy in devising the most elaborate sentiments to express the horror with which they regarded it. It is painful to dwell upon the pictures of hideous anguish which the perturbed imaginations of past generations have conjured up and regarded as the penalties which the merciful Creator had in store for imperfect creatures placed in a state where their imperfections could not fail to lead them into error; but there is this much of comfort about it, that at least those ghastly images were the reflections of the horror with which all that was best in them revolted against moral evil. It is needless to say how easily those conceptions might be turned to the worst purposes, and religion itself be made an instrument not only for restraining the intellects, but for lowering the consciences of mankind. For our present purpose, it is enough to remark that a similar reflection may convince us that, whatever changes of opinion may be in store for us, we need not fear that any scientific conclusions can permanently lower our views of man's duty here. The belief in immortality, diffused throughout the world, was not, more than any other belief, valuable simply on its own account. It was valuable be-

cause it enabled men to rise above the selfishness and the sensuality which otherwise threatened to choke the higher impulses of our nature. But it was the existence of those impulses which gave it its strength, and not any of the metaphysical arguments which can only appeal to a very few exceptional minds. Religions thrive by a kind of natural selection; those which do not provide expression for our best feelings crush out their rivals, not those which are inferred by a process of abstract reasoning. To be permanent, they must bear the test of reason; but they do not owe to it their capacity for attracting the hearts of men. The inference, therefore, from the universality of any creed is not that it is true, for that would prove Buddhism or Mohammedanism as well as Christianity; but that it satisfies more or less completely the spiritual needs of its believers. And, therefore, we may be certain that, if the various tendencies which we have summed up in the name of Darwinism should ultimately become triumphant, they must find some means, though it is given to nobody as yet to define them, of reconciling those instincts of which the belief in immortality was a product. The form may change—we cannot say how widely—but the essence, as every progress in the scientific study of religions goes to show, must be indestructible. When a new doctrine cuts away some of our old dogmas, we fancy that it must destroy the vital beliefs to which they served as scaffolding. Doubtless it has that effect for a time in those minds with whom the association has become indissoluble. That is the penalty we pay for progress. But we may be sure that it will not take root till in some shape or other it has provided the necessary envelopes for the deepest instincts of our nature. If Darwinism demonstrates that men have been evolved out of brutes, the religion which takes it into account will also have to help men to bear in mind that they are now different from brutes.—*Fraser's Magazine.*

ACTION OF DARK RADIATIONS.

By PROF. TYNDALL.

WE now enter upon another inquiry. We have to learn definitely what is the meaning of solar light and solar heat; in what way they make themselves known to our senses; by what means they get from the sun to the earth, and how, when there, they produce the clouds of our atmosphere, and thus originate our rivers and our glaciers.

If in a dark room you close your eyes and press the eyelid with your finger-nail, a circle of light will be seen opposite to the point pressed, while a sharp blow upon the eye produces the impression of a

flash of light. There is a nerve specially devoted to the purposes of vision which comes from the brain to the back of the eye, and there divides into fine filaments, which are woven together to a kind of screen called the *retina*. The retina can be excited in various ways so as to produce the consciousness of light: it may, as we have seen, be excited by the rude mechanical action of a blow imparted to the eye.

There is no spontaneous creation of light by the healthy eye. To excite vision the retina must be affected by something coming from without. What is that something? In some way or other luminous bodies have the power of affecting the retina—but *how?*

It was long supposed that from such bodies issued, with inconceivable rapidity, an inconceivably fine matter, which flew through space, passed through the pores supposed to exist in the humors of the eye, reached the retina behind, and, by their shock against the retina, aroused the sensation of light. This theory, which was supported by the greatest men, among others by Sir Isaac Newton, was found competent to explain a great number of the phenomena of light, but it was not found competent to explain *all* the phenomena. As the skill and knowledge of experimenters increased, large classes of facts were revealed which could only be explained by assuming that light was produced, not by a fine matter flying through space and hitting the retina, but by the shock of minute *waves* against the retina.

Dip your finger into a basin of water, and cause it to quiver rapidly to and fro. From the point of disturbance issue small ripples which are carried forward by the water, and which finally strike the basin. Here, in the vibrating finger, you have a source of agitation; in the water you have a vehicle through which the finger's motion is transmitted, and you have finally the side of the basin which receives the shock of the little waves.

In like manner, according to the *wave-theory* of light, you have a source of agitation in the vibrating atoms, or smallest particles, of the luminous body; you have a vehicle of transmission in a substance which is supposed to fill all space, and to be diffused through the humors of the eye; and, finally, you have the retina, which receives the successive shocks of the waves. These shocks are supposed to produce the sensation of light. We are here dealing, for the most part, with suppositions and assumptions merely. We have never seen the atoms of a luminous body, nor their motions. We have never seen the medium which transmits their motions, nor the waves of that medium. How, then, do we come to assume their existence?

Before such an idea could have taken any real root in the human mind, it must have been well disciplined and prepared by observations and calculations of ordinary wave-motion. It was necessary to know how both water-waves and sound-waves are formed and propagated. It was, above all things, necessary to know how waves, passing through the same medium, act upon each other. Thus disciplined,

the mind was prepared to detect any resemblance presenting itself between the action of light and that of waves. Great classes of optical phenomena accordingly appeared which could be accounted for in the most complete and satisfactory manner by assuming them to be produced by waves, and which could not be otherwise accounted for. It is because of its competence to explain all the phenomena of light that the wave-theory now receives universal acceptance on the part of scientific men.

Let me use an illustration. We infer from the flint implements recently found in such profusion all over England and in other countries, that they were produced by men, and also that the pyramids of Egypt were built by men, because, as far as our experience goes, nothing but men could form such implements or build such pyramids. In like manner, we infer from the phenomena of light the agency of waves, because, as far as our experience goes, no other agency could produce the phenomena.

Thus, in a general way, I have given you the conception and the grounds of the conception, which regards light as the product of wave-motion; but we must go further than this, and follow the conception into some of its details. We have all seen the waves of water, and we know they are of different sizes—different in length and different in height. When, therefore, you are told that the atoms of the sun, and of almost all other luminous bodies, vibrate at different rates, and produce waves of different sizes, your experience of water-waves will enable you to form a tolerably clear notion of what is meant.

As observed above, we have never seen the light-waves, but we judge of their presence, their position, and their magnitude, by their effects. Their lengths have been thus determined, and found to vary from about $\frac{1}{30000}$th to $\frac{1}{60000}$th of an inch.

But, besides those which produce light, the sun sends forth incessantly a multitude of waves which produce no light. The largest waves which the sun sends forth are of this non-luminous character, though they possess the highest heating power. A common sunbeam contains waves of all kinds, but it is possible to *sift* or *filter* the beam so as to intercept all its light, and to allow its obscure heat to pass unimpeded. For substances have been discovered which, while intensely opaque to the light-waves, are almost perfectly transparent to the others. On the other hand, it is possible, by the choice of proper substances, to intercept, in a great degree, the pure heat-waves, and to allow the pure light-waves free transmission. This last separation is, however, not so perfect as the first.

We shall learn presently how to detach the one class of waves from the other class, and to prove that waves competent to light a fire, fuse metal, or burn the hand like a hot solid, may exist in a perfectly dark place.

Supposing, then, that we withdraw, in the first instance, the large

heat-waves, and allow the light-waves alone to pass. These may be concentrated by suitable lenses and sent into water without sensibly warming it. Let the light-waves now be withdrawn, and the larger heat-waves concentrated in the same manner; they may be caused to to boil the water almost instantaneously.

This is the point to which I wished to lead you, and which without due preparation could not be understood. You now perceive the important part played by these large darkness-waves, if I may use the term, in the work of evaporation. When they plunge into seas, lakes, and rivers, they are intercepted close to the surface, and they heat the water at the surface, thus causing it to evaporate; the light-waves at the same time entering to great depths without sensibly heating the water through which they pass. Not only, therefore, is it the sun's fire which produces evaporation, but a particular constituent of that fire, the existence of which you probably were not aware of.

Further, it is these self-same lightless waves which, falling upon the glaciers of the Alps, melt the ice and produce all the rivers flowing from the glaciers; for I shall prove to you presently that the light-waves, even when concentrated to the uttermost, are unable to melt the most delicate hoar-frost; much less would they be able to produce the copious liquefaction observed upon the glaciers.

These large lightless waves of the sun, as well as the heat-waves issuing from non-luminous hot bodies, are frequently called obscure or invisible heat.

We have here an example of the manner in which phenomena, apparently remote, are connected together in this wonderful system of things that we call Nature. You cannot study a snow-flake profoundly without being led back by it step by step to the constitution of the sun. It is thus throughout Nature. All its parts are interdependent, and the study of any one part *completely* would really involve the study of all.

Heat issuing from any source not visibly red cannot be concentrated so as to produce the intense effects just referred to. To produce these it is necessary to employ the obscure heat of a body raised to the highest possible state of incandescence. The sun is such a body, and its dark heat is therefore suitable for experiments of this nature. But in the atmosphere of London, and for experiments such as ours, the heat-waves emitted by coke, raised to intense whiteness by a current of electricity, are much more manageable than the sun's waves. The electric light has also the advantage that its dark radiation embraces a larger proportion of the total radiation than the dark heat of the sun. In fact, the force or energy, if I may use the term, of the dark waves of the electric light is fully seven times that of its light-waves. The electric light, therefore, shall be employed in our experimental demonstrations.

From this source a powerful beam is sent through the room, revealing its track by the motes floating in the air of the room; for, were

the motes entirely absent, the beam would be unseen. It falls upon a concave mirror (a glass one silvered behind will answer), and is gathered up by the mirror into a cone of reflected rays; the luminous apex of the cone, which is the *focus* of the mirror, being about fifteen inches distant from its reflecting surface. Let us mark the focus accurately by a pointer.

And now let us place in the path of the beam a substance perfectly opaque to light. This substance is iodine dissolved in a liquid called bisulphide of carbon. The light at the focus instantly vanishes when the dark solution is introduced. But the solution is intensely transparent to the dark waves, and a focus of such waves remains in the air of the room after the light has been abolished. You may feel the heat of these waves with your hand; you may let them fall upon a thermometer, and thus prove their presence; or, best of all, you may cause them to produce a current of electricity, which deflects a large magnetic needle. The magnitude of the deflection is a measure of the heat.

Our object now is, by the use of a more powerful lamp, and a better mirror (one silvered in front and with a shorter focal distance), to intensify the action here rendered so sensible. As before, the focus is rendered strikingly visible by the intense illumination of the dust-particles. We will first filter the beam so as to intercept its dark waves, and then permit the purely luminous waves to exert their utmost power on a small bundle of gun-cotton placed at the focus.

No effect whatever is produced. The gun-cotton might remain there for a week without ignition. Let us now permit the unfiltered beam to act upon the cotton. It is instantly dissipated in an explosive flash. This experiment proves that the light-waves are incompetent to explode the cotton, while the waves of the full beam are competent to do so; hence we may conclude that the dark waves are the real agents in the explosion. But this conclusion would be only probable; for it might be urged that the *mixture* of the dark waves and the light-waves is necessary to produce the result. Let us, then, by means of our opaque solution, isolate our dark waves and converge them on the cotton. It explodes as before. Hence it is the dark waves, and they only, that are concerned in the ignition of the cotton.

At the same dark focus sheets of platinum are raised to vivid redness; zinc is burnt up; paper instantly blazes; magnesium wire is ignited; charcoal within a receiver containing oxygen is set burning; a diamond similarly placed is caused to glow like a star, being afterward gradually dissipated. And all this while the *air* at the focus remains as cool as in any other part of the room.

To obtain the light-waves we employ a clear solution of alum in water; to obtain the dark-waves we employ the solution of iodine above referred to. But, as before stated, the alum is not so perfect a filter as the iodine; for it transmits a portion of the obscure heat.

Though the light-waves here prove their incompetence to ignite gun-cotton, they are able to burn up black paper; or, indeed, to explode the cotton when it is blackened. The white cotton does not absorb the light, and without absorption we have no heating. The blackened cotton absorbs, is heated, and explodes.

Instead of a solution of alum, we will employ for our next experiment a cell of pure water, through which the light passes without sensible absorption. At the focus is placed a test-tube also containing water, the full force of the light being concentrated upon it. The water is not sensibly warmed by the concentrated waves. We now remove the cell of water; no change is visible in the beam, but the water contained in the test-tube now boils.

The light-waves being thus proved ineffectual, and the full beam effectual, we may infer that it is the dark waves that do the work of heating. But we clinch our inference by employing our opaque iodine filter. Placing it on the path of the beam, the light is entirely stopped, but the water boils exactly as it did when the full beam fell upon it.

And now with regard to the melting of ice. On the surface of a flask containing a freezing mixture we obtain a thick fur of hoar-frost. Sending the beam through a water-cell its luminous waves are concentrated upon the surface of the flask. Not a spicula of the frost is dissolved. We now remove the water-cell, and in a moment a patch of the frozen fur as large as half a crown is melted. Hence, inasmuch as the full beam produces this effect, and the luminous part of the beam does not produce it, we fix upon the dark portion the melting of the frost. As before, we clinch this inference by concentrating the dark waves alone upon the flask. The frost is dissipated exactly as it was by the full beam.

These effects are rendered strikingly visible by darkening with ink the freezing mixture within the flask. When the hoar-frost is removed, the blackness of the surface from which it had been melted comes out in strong contrast with the adjacent snowy whiteness. When the flask itself, instead of the freezing mixture, is blackened, the purely luminous waves, being absorbed by the glass, warm it; the glass reacts upon the frost, and melts it. Hence the wisdom of darkening, instead of the flask itself, the mixture within the flask.

This experiment proves to demonstration that it is the dark waves of the sun that melt the mountain snow and ice, and originate all the rivers derived from glaciers.

There are writers who seem to regard science as an aggregate of facts, and hence doubt its efficacy as an exercise of the reasoning powers. But all that I have here taught you is the result of reason, taking its stand, however, upon the sure basis of observation and experiment. And this is the spirit in which our further studies are to be pursued.

THE NATURAL HISTORY OF MAN.

A COURSE OF LECTURES BY A. DE QUATREFAGES.

TRANSLATED BY ELIZA A. YOUMANS.

II.—The Antiquity of Man.

GENTLEMEN: I shall to-day continue the Natural History of Man, which I have undertaken to give you entire. Those of you who were present at our first lecture know that it was devoted to the examination of a fundamental question. We inquired if all the men living upon earth, however they may differ among themselves, are of one and the same species; that is, if they are to be regarded as descended from a single primitive pair.

To answer this question, we appealed to science alone. We started with the principle that, so far as the body is concerned, man is an animal—nothing more, nothing less; that, consequently, all the general laws to which animals are subject bear upon him, and he cannot evade their dominion.

We then asked, not only of animals, but also of plants, What is meant by the word *species?* and we were led to distinguish species from *race.*

Without going into the details I then gave, this distinction is easily established. When two individuals of different species unite, the union is almost always infertile, and, if the first union is fertile, the offspring, either immediately or at the end of a few generations, will reproduce no more. So that, between two species, we cannot establish a third series of individuals, starting at first with a father and a mother taken from two distinct species. The examples I gave are known to you all. When we unite a jackass with a mare, an ass with a stallion, we obtain a mule or a hinny, and never a horse or an ass; and, to get mules, it is always necessary to have recourse to a jackass and a mare.

When, on the contrary, we take two individuals of two different races of the same species, whatever their differences of exterior conformation, the resulting individual is fertile, and may give birth to an intermediate series of individuals between the two races.

As examples, I took the different races of dogs, of sheep, of cattle. Whatever the skin, the color, the form, the proportions of the dog, he remains a dog; whatever the proportions, the figure, the color of horses or of oxen, they remain horses and oxen. So, when we cross a water-spaniel with a greyhound, a lap-dog with a Havana dog, the offspring are fertile, and we get what are called fertile mixed races.

Now, when human beings unite with each other, whatever their exterior differences, whether they are white, or black, or yellow, these marriages are fertile. From this fact, verified a thousand times, we

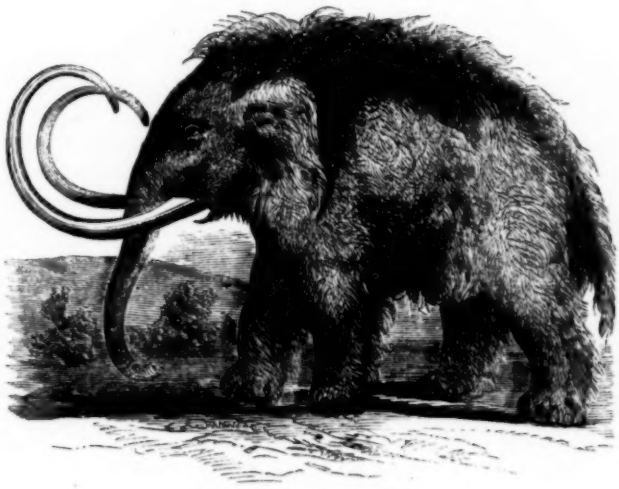
draw the conclusion that there is but one species of men, and that the differences existing between them are only differences of race. Again I say, in reaching this conclusion, we have never gone beyond science. I repeat this declaration, because, in all that I shall say to you, I wish you distinctly to understand that I never put foot outside the domain of science, where alone the scientific man can speak with authority.

The unity of the human species once demonstrated, many problems arise before us.

The first is that of the antiquity of man. Have men been always upon the earth? Did they appear at the same time with the other species of animals? Are they very ancient on the globe? Such are the first questions which present themselves to our minds.

Throughout all time have men lived on the earth? Many of you,

FIG. 1.



Extinct Elephant, or Mammoth.

doubtless, are already able to answer me. My brother professors of geology and paleontology have probably addressed you on these questions. I shall only recall to you the general facts bearing upon the case.

You all know what is the action of heat upon certain bodies. For example, you all know that water heated to a certain degree vaporizes; that if this vapor loses a certain quantity of heat, it is liquefied; that in losing still more, it forms a solid body—ice. This ice may become so solid, that in St. Petersburg they have been able to construct it into palaces, and have made cannons of ice that have been fired. You can understand that a sufficient quantity of heat will reduce all bodies to vapor, and that sufficient cold will solidify them.

Now, the facts of astronomy seem to prove that, of old, our earth,

with all it contains, and all the materials that compose it, began as a vast, vaporous mass diffused in space. It was a globe of vapor. When the process of cooling set in, this mass became liquid, and, during periods of time which we cannot compute, it was only a vast mass of rocks and of matter melted by fire.

It is needless to insist on the fact that, at this epoch, on the surface of our globe, there were no living beings, and consequently no men.

The cooling progressing, there is formed a pellicle on the surface of the globe, and this pellicle goes on increasing in thickness. This is what we will call the primitive earth. On this primitive earth, during a long period, water could not exist in a liquid state, and consequently there were as yet upon our globe no living beings, for all these beings need water; and, of course, no men.

But the process of cooling continued. The water which was vaporized in the atmosphere fell in torrents on this crust which enveloped the globe; chemical reactions, of a violence of which we can form no idea, were produced. At this moment began the formation of what we call the earth of transport, and the globe entered upon what is called the Secondary epoch.

Strictly we may say that, from the moment the waters rested in a liquid state upon the surface of the earth, life might begin to manifest itself. In certain thermal waters of high temperature, we find confervæ—microscopic vegetables which are already organized and living. But no animal could yet live in this medium, for the heat would coagulate its albumen. Later, the cooling always progressing and the sea enveloping the greater part of the globe, more complex vegetables appeared. Soon animals, chiefly aquatic, made their appearance, and among them I would mention those gigantic reptiles you have sometimes seen represented in certain book announcements on the walls of Paris. Mammals—man—could not yet inhabit our globe.

As the cooling progressed, continents were formed by the upturnings of Nature. The time came when true mammals and birds, analogous to living species, appeared in their turn. This was the commencement of the Tertiary epoch. Then, very probably, man might have lived. We shall presently have to ask if he did not exist, at least in the latter part of this period.

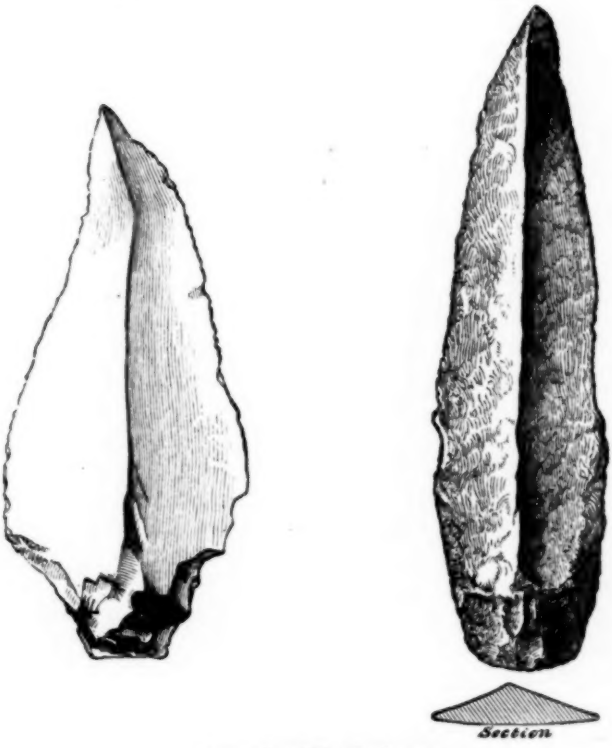
The dislocation of the crust of the globe elevated the mountains, dug the valleys, sank the seas, formed the continents, and, toward the end of the Tertiary period, the globe presented a surface much resembling what we see now. Here commences the Quaternary period. This quaternary period presents to us a very remarkable phenomenon.

Up to this time, putting out of account the slight oscillations that have occurred, the globe seems to have cooled in a nearly uniform manner, from the time when it formed only a mass of vapor, down to the Tertiary epoch. With the Quaternary period came a moment

wherein a cooling, perhaps sudden, but in any case very marked, showed itself and then disappeared.

At this moment, a part of the globe at least, and Europe in particular, was much colder than it is now. We have proof of this in the glaciers of the Alps. Instead of stopping at the place where they do now, these glaciers filled most of the Swiss valleys, descending even in the valley of the Rhone; and from one end to the other of these valleys enormous blocks of rock were transported by the glaciers, and

Fig. 2. Fig. 3.



Arrow-shaped Flint Implements.

left on the spot. It is these which now constitute what we call erratic blocks.

During the Quaternary epoch, there lived in France very different animals from those which we find now. Among them I may refer to the great cave-bears, which were remarkable for their size and for their bulging foreheads. I will also mention the hyena. You know that now we have no hyenas, and that they are only found in countries much warmer than France. To the preceding species I will add the rhinoceros. I call attention particularly to an elephant, of which this is the picture (Fig. 1), and which we call the mammoth. This elephant,

you see, is easily distinguished from species now living; by its size, first, for it is much larger than they; then by the form of its remarkably recurved tusks; finally and chiefly because, in place of the naked skin of the elephants we know, he was covered with a thick wool and very long hairs.

Of all this we are certain; for this elephant has been found preserved whole, with his skin and his hairs. At different times they have discovered in the frozen earth of Siberia the dead bodies of these animals. That country contains in such great numbers the tusks of these antediluvian elephants, to employ a vulgar expression, that the commerce in fossil ivory constitutes a considerable source of revenue, and the state reserves a monopoly of it.

I call special attention to this elephant, and we shall presently see why.

The Quaternary period ended as those that preceded it; and then began the present period. Since the time of its commencement, the continents, the flora, and the faunæ, have not undergone any considerable modifications.

Nobody has ever questioned the existence of man at the beginning of the present period, and some have even considered his appearance as the characteristic feature of this period. But did man exist before? To employ the common expression, were there antediluvian men? In other words, and to return to scientific language, is man the contemporary of those animal species among which appears the mammoth? May he be found, like the mammoth, in a fossil state?

Such is the question that has been often put, and which was long answered in the negative. Down to these later times, the most eminent men in Natural History, in Geology, in Paleontology, were all agreed on this point, and I need only state that Cuvier, in particular, never admitted the existence of fossil man.

To-day we are led by many well-ascertained facts to answer this question very differently. We are forced to admit that fossil man does really exist, and that man was contemporary with those species of animals I have been speaking of, especially with the mammoth.

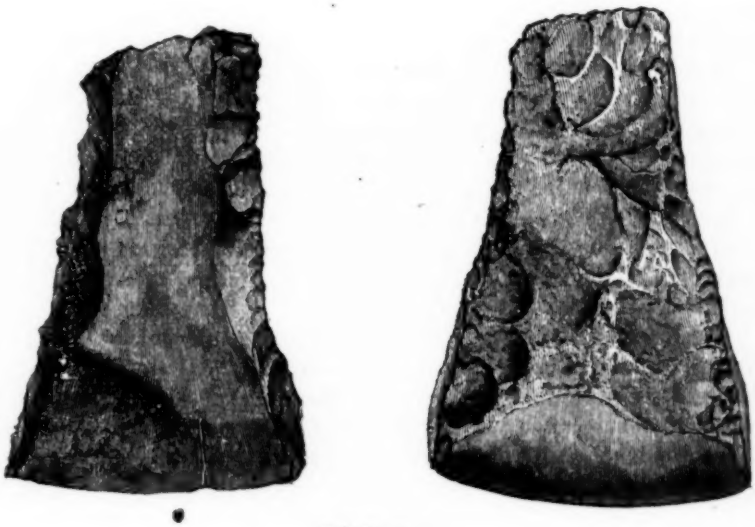
This is certainly one of the most beautiful discoveries of modern times! The ground for it was laid by the establishment of a certain number of facts observed in England, in Germany, in France. But the honor of having brought decisive proofs, which convince everybody, belongs incontestably to two Frenchmen—to M. Boucher de Perthes, and to M. Edouard Lartet.

M. Boucher de Perthes, the eminent archæologist of Abbeville, while inspecting the excavations made in the earth around his native village, at Menchecourt, and at Moulin-Quignon, discovered stones fashioned in a peculiar manner, and the same form was constantly reproduced. It was soon evident to him that this circumstance was not accidental, but that these stones owed their form to human industry.

Now, these polished flints (Figs. 2 and 3), these stone hatchets (Figs. 4 and 5), were found in the earth associated with the bones of elephants; whence he concluded that the men who had fashioned them lived at the same epoch with those great mammifers long since extinct.

This conclusion, drawn by M. Boucher de Perthes, was at first vigorously contested. In particular, some of the men whose decisions have justly the highest authority on questions relating to the history of the earth, thought that the chipped flints and the bones of elephants

Fig. 4. Fig. 5



Flint Hatchets.

were found together in the same bed because this bed had been altered. They said: A first bed was formed which enclosed the bones of elephants. On this bed, during the present period, men lived and have left these chipped flints as a trace of their presence. Then came a mighty tempest, which rolled and confounded together the hatchets and the elephants' bones. Hence we now find them side by side, although the bed to which they belong contains the remains of two perfectly distinct epochs.

It will be apparent to you that, if, in our day, men were buried in this bed of Menchecourt and of Moulin-Quignon, and, if a great storm should come and mingle these modern bones with the hatchets and bones of elephants, our grandchildren would find them all mixed together, and yet the men of to-day are not contemporaneous with the hatchets you see before you.

The objection was all the stronger for having been advanced, as I have said, by the highest authorities in Geology. This is why I attach

such importance to the facts, for which we are indebted to M. Lartet, and which entirely refute these conjectures.

M. Lartet studied at Aurignac, in the south of France, a burial-place of these remote times. It is a grotto excavated in the side of a hill, at a height which is not attained by water-courses analogous to those of which we find the trace in the neighborhood of Abbeville. This sepulchral grotto at the time of discovery was closed by a slab taken from a bed of rocks at some distance from this point. In the interior were found the bones of seventeen persons, men, women, and children; and before the entrance were found the well-attested remains of a fireplace. There were traces of funeral repasts that the first inhabitants of our country were in the habit of making, and such as we sometimes find in our own day among certain European peoples. In the ashes of this fireplace were found bones bearing the trace of fire, and excrements of wild animals. These bones, scorched by the fire, bearing traces of the hand of man, were the bones of the bear and of the rhinoceros. The excrements were those of a species of hyena contemporaneous with the preceding animals. Here, consequently, man appears as eating the animals in question; as making his repast of those very animals whose contemporaneousness with him had been disputed.

M. Lartet crowned these beautiful researches by discovering in a cave, in the centre of France, a piece of ivory on which was unmistakably represented the very mammoth (Fig. 6) to which I have just called your attention. It is very evident that this picture could only be made by a man who lived at the same time with this elephant.

In view of M. Lartet's discoveries, we must admit the existence of fossil man, that is to say, the coexistence of our species with the lost species of animals of which I have spoken.

Since this epoch, besides, we have not only found traces of these primitive industries, but *débris* of jawbones, and entire crania. Hence we can judge of the characters which distinguished our first ancestors. Strange to tell, we find that these men who, even in France, warred with stone weapons such as I have shown you, against the elephant and the rhinoceros, have still at the present day in Europe descendants presenting the same characters.

So man lived in the Quaternary epoch. May we go further, and admit that he also existed during the Tertiary epoch? Was he contemporaneous, not only with the rhinoceros and mammoth, of which I have spoken, but also with earlier mammals?

The question is perhaps still premature. Some facts seem to indicate that it is so; but in such matters it is better to adjourn conviction than to admit opinions that are yet in doubt. Consequently, we shall regard the debate as remaining open.

After demonstrating that man goes back in geologic time to an epoch much anterior to that in which we formerly believed, we are

naturally led to ask if it is possible to estimate in figures this antiquity of our species. We are obliged up to the present time to answer, No.

Fig. 6.

Sketch of Fossil Mammoth on Ivory, found among Cave Relics.

We can perfectly establish relative epochs; but we cannot judge of the number of years that each of these epochs represents.

This, however, has been attempted. From calculations of the time required to form a bed of peat, some have attempted to compute the duration of certain periods of the age of stone, of the age of bronze, and of the age of iron.

But the results have been so discordant as to throw doubt upon the method. Then the accumulations of *débris* thrown up by torrents of the Alps have been studied, and, in particular, an accumulation of this kind known under the name of the cone of Tinnière. A railroad has cut through these materials, which have probably been accumulating ever since the commencement of the present epoch, and in the cut there have been found *débris* reaching back in one case to the Gallo-Roman epoch, in others to the Roman epoch—these to the epoch of iron, those to that of bronze, and, finally, to the epoch of stone.

As we know the duration of some of these periods, it has been thought possible by a simple proportion, taking account of the thickness of the beds, to go back to the epoch of the first formation of the cone. But here again, I repeat, the results are so uncertain that we cannot give them any serious confidence.

We cannot, then, give precise figures. Yet, from all these researches, and from archæologic facts not less demonstrated, it results that it is necessary to go back much farther than we have been accustomed to, to look for the advent of man upon the earth. Let me cite you just one of these proofs.

You were at the Universal Exposition—probably you entered the Egyptian Temple. At the bottom of the hall, facing the entrance, you saw a statue—that of King Cephren. This statue goes back something like four thousand years before our era. Consequently, it was sculptured about six thousand years ago. Now, you may know that the work was very difficult, for the stone of which it is made is very hard. The statue is remarkably perfect. From this, as well as from other data, we learn that in Egypt, six thousand years ago, civilization was already much advanced. We must, therefore, date back the origin of the Egyptians more than six thousand years. But we shall presently see that Egypt was not the first inhabited country. Man must have come there from his original home. Consequently, his first appearance on the globe will be found much more remote in time.

So we are now certain of the existence of Quaternary man; we already suspect the existence of Tertiary man, and it is precisely in our country that the discoveries which led to these conclusions were made.

SCRUTABLE PROVIDENCES.

WHEN, the other day, a juror in one of the Westfield suits refused to award damages against the steamboat company, on the ground that the disaster could have happened only by the direct will of God, and was simply an inscrutable Providence, the community heard him with a suppressed titter, which, if it implied tolerance for his convictions, implied equal contempt for his understanding. For it was patent to every mind but his own that a worn-out boiler must explode at the very instant when all conditions favored that catastrophe, and that the men who knew that that instant was imminent, yet hourly solicited travellers to a possible death, were morally guilty, not only of criminal neglect and deceit, but of murder.

But many candid men, who saw clearly the accountability of the Westfield owners and managers, shake their heads just now over what seems to them a really mysterious visitation of God—the Persian famine. And because all great and inexplicable calamities pain loving hearts, and sadden, if they do not obscure the faith of many souls, it seems worth while to look a moment at this subject of Inscrutable Providences.

Here is this case of the Persian famine. For unknown years the Persians have been cutting off their trees, and diminishing their rainfall thereby. Nay, not only has the removal of the forests decreased the supply, but it has wasted whatever rain fell. For the roots of the trees, and of all the innumerable shrubs and bushes and vines and ferns that thrive in their shadow, kept the ground open and held the water in countless natural wells for the use of the soil in droughts. But all the undergrowth dying when its protecting forests were felled, the scanty showers percolated into the streams at once, causing rare floods and frequent droughts. The droughts yielded no harvests, and no harvests were followed by pestilence, famine, and death. Now, for three years no rain has fallen on the blistered fields, and a nation apparently is dying. The very first drought was the kindly warning of Heaven against the violation of natural laws. Men were too heedless or too ignorant to accept it; and the sins of the fathers are to-day visited on the children, not in the vengeance of an awful Power, but in the discipline of relentless law. Is not this a Providence so scrutable that he who runs may read?

When, in Chicago, a night's fire undid a generation's toil, spreading misery and death broadcast, was that horror in the least degree inexplicable? Every man who, within thirty years, had put up a wooden house in a city whose familiar breezes were gales, and whose gales were hurricanes, solicited that rain of fire. They who, hasting to be rich, fell into the snare of cheap and dangerous building, digged, every man, a pit for his neighbor's feet as well as for his own. The inscru-

table aspect of the calamity was that it had not come years before. And the providential lesson would seem to be that laws of matter are laws of God, and cannot be violated with impunity.

When the earthquake wellnigh swallowed up Peru, five or six years ago, men stood aghast at the mysterious dispensation. But Heaven has not only always declared that tropical countries are liable to earthquakes, but had taught the Peruvians through hundreds of years to expect two earthquakes in a century, travelling in cycles from forty to sixty years apart. The citizens of Africa have not only this general instruction, but that special warning which Nature always gives. A great light appeared to the southeast. Hollow sounds were heard. The dogs, the goats, even the swine, foresaw the evil, and hid themselves. But the simple men passed on and were punished.

Before the Alpine freshets come, the streams are coffee-colored. Even the tornadoes of the tropics, which are instantaneous in their swoop, so plainly announce themselves to old sailors, that they reef sails and save ship and life, while only the heedless perish. The simoom gives such certain and invariable warnings that the caravan is safe if it be wary.

Herculaneum and Pompeii were built too far up the mountain. And that the builders knew quite as well as the excavators of the splendid ruins know it now. But they chose to take the risk. And to-day their cheerful compatriots gather their heedless vintage and sit beneath their perilous vines still nearer to the deadly crater. St. Petersburg has been three times inundated, and after each most fatal calamity processions filled the streets and masses were said to propitiate the mysterious anger of God. Peter the Great, who built the city, was the successor of Canute. He ordered the Gulf of Kronstadt to retire, and then set down his capital in the swamps of the verge of the Neva. Whenever the river breaks up with the spring-floods, the trembling citizens are at sea in a bowl. Only three times has the bowl broken, so much money and skill have been expended upon it. But when a March gale shall drive the tide back upon the river, swollen and terrible with drifting ice, drowned St. Petersburg will be the pendant for burned Chicago.

Modern science has brought the world a fifth gospel. In it we read that God commands us to give him our whole heads as well as our whole hearts, for that we cannot know him nor obey him till we discern him in every minutest fact, and every immutable law of the physical universe, as in every fact and law of the moral. It is barely two hundred years since the great Cotton Mather preached a famous sermon called "Burnings Bewailed," wherein he attributed a terrible conflagration to the wrath of God kindled against Sabbath-breaking and the accursed fashion of monstrous periwigs! For years after his time the Puritan colonies held fasts for mildew, for small-pox, for caterpillars, for grasshoppers, for loss of cattle by cold and visitation of

God. They saw an Inscrutable Providence in all these things. But, when their children had learned a better husbandry and better sanitary conditions, the "visitations" ceased.

In the perfect providence of God there are no surprises. If there seem to be, it is that we have suffered ourselves to be taken unawares. We must work out our own salvation. The book of natural phenomena is opened wide before every man, and he is set to learn it for his own good. If he will not study it through reverence and love, he is taught it through pain. But the pain itself is the beneficence of a perfect law, and it is a constant testimony to the goodness and tenderness of God that calamity—not less than prosperity—is a Scrutable Providence.—*Christian Union.*

THE PHYSIOLOGICAL POSITION OF ALCOHOL.

By B. W. RICHARDSON, M. D., F. R. S.

IN whatever mode alcohol may be passed into the living body to produce modification of physical action, the changes it excites are remarkably uniform, and, other things being equal, the amount required to induce the changes is also uniform. Thus, I have found, by many researches, that the proportion of sixty grains of alcohol to the pound weight of the animal body is the quantity capable of producing an extreme effect.

The order of the changes induced is, in like manner, singularly uniform, and extends in a methodical way through all classes of animals that may be subjected to the influence; and, as the details of this part of my subject are the facts that concern us most, I shall expend some time in their narration.

The first symptom of moment that attracts attention, after alcohol has commenced to take effect on the animal body, is what may be called vascular excitement; in other words, over-action of the heart and arterial vessels. The heart beats more quickly, and thereupon the pulse rises. There may be some other symptoms of a subjective kind—symptoms felt by the person or animal under the alcohol—but this one symptom of vascular excitement is the first objective symptom, or that which is presented to the observer. I endeavored in one research to determine from observations on inferior animals what was the actual degree of vascular excitement induced by alcohol, and my results were full of interest. They have, however, been entirely superseded by the observations made on the human subject by Dr. Parkes and Count Wollowicz.

These observers conducted their inquiries on the young and healthy

adult man. They counted the beats of the heart, first at regular intervals, during what were called water periods, that is to say, during periods when the subject under observation drank nothing but water; and next, taking still the same subject, they counted the beats of the heart during successive periods in which alcohol was taken in increasing quantities; thus step by step they measured the precise action of alcohol on the heart, and thereby the precise primary influence induced by alcohol. Their results were as follows:

The average number of beats of the heart in 24 hours (as calculated from eight observations made in 14 hours), during the first or water period, was 106,000; in the alcoholic period it was 127,000, or about 21,000 more; and in the brandy period it was 131,000, or 25,000 more.

The highest of the daily means of the pulse observed during the first or water period was 77.5; but on this day two observations are deficient. The next highest daily mean was 77 beats.

If, instead of the mean of the eight days, or 73.57, we compare the mean of this one day, viz., 77 beats per minute, with the alcoholic days, so as to be sure not to over-estimate the action of the alcohol, we find:

On the 9th day, with one fluidounce of alcohol, the heart beat 430 times more.

On the 10th day, with two fluidounces, 1,872 times more.

On the 11th day, with four fluidounces, 12,960 times more.

On the 12th day, with six fluidounces, 30,672 times more.

On the 13th day, with eight fluidounces, 23,904 times more.

On the 14th day, with eight fluidounces, 25,488 times more.

But as there was ephemeral fever on the 12th day, it is right to make a deduction, and to estimate the number of beats in that day as midway between the 11th and 13th days, or 18,432. Adopting this, the mean daily excess of beats during the alcoholic days was 14,492, or an increase of rather more than 13 per cent.

The first day of alcohol gave an excess of 4 per cent., and the last of 23 per cent.; and the mean of these two gives almost the same percentage of excess as the mean of the six days.

Admitting that each beat of the heart was as strong during the alcoholic period as in the water period (and it was really more powerful), the heart on the last two days of alcohol was doing one-fifth more work.

Adopting the lowest estimate which has been given of the daily work done by the heart, viz., as equal to 122 tons lifted one foot, the heart, during the alcoholic period, did daily work in excess equal to lifting 158 tons one foot, and in the last two days did extra work to the amount of 24 tons lifted as far.

The period of rest for the heart was shortened, though, perhaps, not to such an extent as would be inferred from the number of beats

for each contraction was sooner over. The heart, on the fifth and sixth days after alcohol was left off, and apparently at the time when the last traces of alcohol were eliminated, showed in the sphygmographic tracings signs of unusual feebleness; and, perhaps, in consequence of this, when the brandy quickened the heart again, the tracings showed a more rapid contraction of the ventricles, but less power, than in the alcoholic period. The brandy acted, in fact, on a heart whose nutrition had not been perfectly restored.

It is difficult, at first glance, to realize the excessive amount of work performed by the heart under this extreme excitement. Little wonder is it that, after the labor imposed upon it by six ounces of alcohol, the heart should flag; still less wonder that the brain and muscles which depend upon the heart for their blood-supply should be languid for many hours, and should require the rest of long sleep for renovation. It is hard physical work, in short, to fight against alcohol; harder than rowing, walking, wrestling, carrying heavy weights, coal-heaving, or the tread-wheel itself.

While the heart is thus laboring under the action of alcoholic stimulation, a change is observable in the extreme circulation—that circulation of blood which by varying shades of color in exposed parts of the body, such as the cheek, is visible to the eye. The peripheral circulation is quickened, the vessels distended. We see this usually in persons under the influence of wine in the early stage, and we speak of it as the flush produced by wine. The authors I have already quoted report upon it in definite terms: "The peripheral circulation (during alcoholic excitement) was accelerated, and the vessels were enlarged, and the effect was so marked as to show that this is an important influence for good or for evil when alcohol is used."

By common observation the flush seen on the cheek during the first stage of alcoholic excitation is supposed to extend merely to the parts actually seen. It cannot, however, be too forcibly impressed on the mind of the reader that the condition is universal in the body. If the lungs could be seen, they, too, would be found with their vessels injected; if the brain and spinal cord could be laid open to view, they would be discovered in the same condition; if the stomach, the liver, the spleen, the kidneys, or any other vascular organs or parts could be laid open to the eye, the vascular enlargement would be equally manifest.

In course of time, in persons accustomed to alcohol, the vascular changes, temporary only in the novitiate, become confirmed and permanent. The bloom on the nose which characterizes the genial toper is the established sign of alcoholic action on vascular structure.

Recently some new physiological inquiries have served to explain the reason why, under alcohol, the heart at first beats so quickly and why the pulses rise. At one time it was imagined that the alcohol acted immediately upon the heart, stimulating it to increased action,

and from this idea—false idea, I should say—of the primary action of alcohol, many erroneous conclusions have been drawn. We have now learned that there exist many chemical bodies which act directly by producing a paralysis of the organic nervous supply of the vessels which constitute the minute vascular circuit. These minute vessels when paralyzed offer inefficient resistance to the stroke of the heart, and the heart thus liberated, like the mainspring of a clock from which the resistance has been removed, quickens in action, dilating the minute and feebly-acting vessels, and giving evidence really not of increased but of wasted power.

The phenomena noticed above constitute the first stage of alcoholic action on the body; we may call it the stage of excitement; it corresponds with a similar stage or degree caused by chloroform.

If the action of alcohol be carried further, a new set of changes is induced in another part of the nervous system—the spinal system. Whether this change be due simply to the modification of the circulation in the spinal cord, or to the direct action of the alcohol upon the nervous matter, is not yet known, but the fact of change of function is well marked, and it consists of deficient power of coördination of muscular movement. The nervous control of certain of the muscles is lost, and the nervous stimulus is more or less enfeebled. The muscles of the lower lip in the human subject usually fail first of all, then the muscles of the lower limbs, and it is worthy of remark that the flexor muscles give way earlier than the extensors. The muscles themselves by this time are also failing in power; they respond more feebly than is natural to the galvanic stimulus; they, too, are coming under the depressing influence of the paralyzing agent, their structure temporarily changed, and their contractile power everywhere reduced. This modification of the animal functions under alcohol marks the second degree of its action. In this degree, in young subjects, there is usually vomiting, and in birds this symptom is invariable. Under chloroform there is produced a degree or stage of action holding the same place in the order of phenomena.

The influence of the alcohol continued still longer, the upper portions of the cerebral mass, or larger brain, become implicated. These are the centres of thought and volition, and as they become unbalanced and thrown into chaos, the mind loses equilibrium, and the rational part of the nature of the man gives way before the emotional, passional, or mere organic part. The reason now is off duty, or is fooling with duty, and all the mere animal instincts and sentiments are laid atrociously bare. The coward shows up more craven, the braggart more braggart, the bold more bold, the cruel more cruel, the ignorant more ignorant, the untruthful more untruthful, the carnal more carnal. "*In vino veritas*" expresses faithfully, indeed even to physiological accuracy, a true condition. The spirits of the emotions are all in revel, and are prepared to rattle over each other in wild disorder;

foolish sentimentality, extending to tears, grotesque and meaningless laughter, absurd promises and asseverations, inane threats or childish predictions impel the tongue, until at last there is failure of the senses, distortion of the objective realities of life, obscurity, sleep, insensibility, and utter muscular prostration. This constitutes the third stage of alcoholic intoxication. It is the stage of insensibility under chloroform when the surgeon performs his painless task.

While these changes in the action of the nervous system are in progress there is a peculiar modification proceeding in respect to the temperature of the body. For a little time the external or surface temperature is increased, especially in those parts that are unduly charged and flushed with blood. But it is to be observed that in respect to the mass of the body the tendency is to a fall of temperature. In the progress toward complete intoxication under alcohol, however, there are, as we have already seen, three degrees or stages. The first is a stage of simple exhilaration, the second of excitement, the third of rambling insensibility, and the fourth of entire unconsciousness, with muscular prostration. The duration of these stages can be modified in the most remarkable manner by the mode of administration; but whether they are developed or recovered from in an hour or a day, they are always present except in cases where the quantity of alcohol administered is in such excess that life instantly is endangered or destroyed. In the first or exhilarative stage the temperature undergoes a slight increase; in birds a degree Fahrenheit, in mammals half a degree. In the second degree, during which there is vomiting in birds, or attempts at vomiting, the temperature comes back to its natural standard, but soon begins to fall; and during the third degree the decline continues. The third degree fully established, the temperature falls to its first minimum, and in birds comes down from five and a half to six degrees; in rabbits from two and a half to three degrees. In this condition the animal temperature often remains until there are signs of recovery, viz., conscious or semi-conscious movements, upon which there may be a second fall of temperature of two or even three degrees in birds. In this course of recovery I have seen, for instance, the temperature of a pigeon which had a natural standard of 110° Fahr. reduced to 102°. Usually with this depression of force there is a desire for sleep, and with perfect rest in a warm air there is a return of animal heat; but the return is very slow, the space of time required to bring back the natural heat being from three to four times longer than that which was required to reduce it to the minimum.

In these fluctuations of temperature the ordinary influences of the external air play an important part as regards duration of the fluctuation, and to some extent as regards extremes of fluctuation.

These facts respecting fall of temperature of the animal body under alcohol were derived from observations originally taken from the inferior animals; they have been confirmed since by other observers,

from the human subject. Dr. De Marmon, of King's Bridge, New York, has specially proved this fact in some instances of poisoning by whiskey in young children. In one of these examples the temperature of the body fell from the natural standard of 98° Fahr. to 94°, in another to 93½°.

Through all the three stages noticed in the above, the decline of animal heat is a steadily-progressing phenomenon. It is true that in the first stage the heat of the flushed parts of the body is for a brief time raised, but this is due to greater distribution of blood and increased radiation, not to an actual increment of heat within the body. The mass of the body is cooling, in fact, while the surfaces are more briskly radiating, and soon, as the supply of heat-motion fails, there is fall of surface temperature also; a fall becoming more decided from hour to hour up to the occurrence of the fourth and final stage, of which I have now to treat.

The fourth degree of alcoholic intoxication is one of collapse of the volitional nervous centres, of the muscular organs under the control of those centres, and of some of the organic or mere animal centres. It is true that, while the body lies prostrate under alcohol, there are observed certain curious movements of the limbs, but these are not stimulated from the centres of volition, nor are they reflected motions derived from any external stimulus; they are strange automatic movements, as if still in the spinal cord there were some life, and they continue irregularly nearly to the end of the chapter, even when the end is death.

Through the whole of this last stage two centres remain longest true to their duty, the centre that calls into play the respiratory action, and the centre that stimulates the heart. There is then an interval during which there are no movements whatever, save these of the diaphragm and the heart, and, when these fail, the primary failure is in the breathing-muscle: to the last the heart continues in action.

The leading peculiarity of the action of alcohol is the slowness with which the two centres that supply the heart and the great respiratory muscle are affected. In this lies the comparative safety of alcohol: acting evenly and slowly, the different systems of organs die after each other, or together, gently, with the exception of those two on which the continuance of mere animal life depends. But for this provision, every deeply-intoxicated animal would inevitably die.

It happens usually, nevertheless, that under favorable circumstances the intoxicated live: the temperature of the body sinks two or three degrees lower, but the alcohol diffusing through all the tissues, and escaping by diffusion and elimination, the living centres are slowly relieved, and so there is slow return of power. If death actually occurs, the cause of it is condensation of fluid on the bronchial surfaces and arrest of respiration from this purely mechanical cause. The animal is literally drowned in his own secretion. Such are the stages

or degrees of alcoholic narcotism, from the first to the last. Let me add two or three observations.

In the first place, we gather that this agent is a narcotic. I have compared it throughout to chloroform, and the comparison is good in all respects save one, viz., that alcohol is less fatal than chloroform as an immediate destroyer.

The well-proven fact that alcohol, when it is taken into the body, reduces the animal temperature, is full of the most important suggestions. It shows that alcohol does not in any sense act as a supplier of vital heat, as is so commonly supposed, and that it does not prevent the loss of heat, as those imagine "who take just a drop to keep out the cold." It shows, on the contrary, that cold and alcohol in their effects on the body run closely together, an opinion most fully confirmed by the experience of those who live or travel in cold regions of the earth.

The conclusive evidence now in our possession that alcohol taken into the animal body sets free the heart, so as to cause the excess of motion of which the record has been given above, is proof that the heart, under the frequent influence of alcohol, must undergo deleterious change of structure. It may, indeed, be admitted in proper fairness, that when the heart is passing through this rapid movement it is working under less pressure than when its movements are slow and natural; and this allowance must needs be made, or the inference would be that the organ ought to stop at once in function by the excess of strain put upon it.

I cannot, by any argument yet presented to me, admit the alcohols by any sign that should distinguish them from other chemical substances of the exciting and depressing narcotic class. When it is physiologically understood that what is called stimulation or excitement is, in absolute fact, a relaxation, I had nearly said a paralysis, of one of the most important mechanisms in the animal body—the minute, resisting, compensating circulation—we grasp quickly the error, in respect to the action of stimulants, in which we have been educated, and obtain a clear solution of the well-known experience that all excitement, all passion, leaves, after its departure, lowness of heart, depression of mind, sadness of spirit. In the scientific education of the people no fact is more deserving of special comment than this fact, that excitement is wasted force, the running down of the animal mechanism before it has served out its time of motion.

It will be said that alcohol cheers the weary, and that to take a little wine for the stomach's sake is one of those lessons that come from the deep recesses of human nature. I am not so obstinate as to deny this argument. There are times in the life of man when the heart is oppressed, when the resistance to its motion is excessive, and when blood flows languidly to the centres of life, nervous and muscular.

In these moments alcohol cheers. It lets loose the heart from its oppression, it lets flow a brisker current of blood into the failing organs; it aids nutritive changes, and altogether is of temporary service to man. So far alcohol is good, and if its use could be limited to this one action, this one purpose, it would be among the most excellent of the gifts of Nature to mankind.

It is assumed by most persons that alcohol gives strength, and we hear feeble persons saying daily that they are being kept up by stimulants. This means actually that they are being kept down, but the sensation they derive from the immediate action of the stimulant deceives them and leads them to attribute lasting good to what, in the large majority of cases, is persistent evil. The evidence is all-perfect that alcohol gives no potential power to brain or muscle. During the first stage of its action it may enable a wearied or feeble organism to do brisk work for a short time; it may make the mind briefly brilliant; it may excite muscle to quick action, but it does nothing at its own cost, fills up nothing it has destroyed as it leads to destruction.

On the muscular force the very slightest excess of alcoholic influence is injurious. I find, by measuring the power of muscle for contraction in the natural state and under alcohol, that, so soon as there is a distinct indication of muscular disturbance, there is also indication of muscular failure, and if I wished, by scientific experiment, to spoil for work the most perfect specimen of a working animal, say a horse, without inflicting mechanical injury, I could choose no better agent for the purpose of the experiment than alcohol. But alas! the readiness with which strong, well-built men slip into general paralysis under the continued influence of this false support, attests how unnecessary it were to put a lower animal to the proof of an experiment. The experiment is a custom, and man is the subject.

It may be urged that men take alcohol, nevertheless, take it freely and yet live; that the adult Swede drinks his average cup of twenty-five gallons of alcohol per year, and yet remains on the face of the earth. I admit force even in this argument, for I know that under the persistent use of alcohol there is a secondary provision for the continuance of life. In the confirmed alcoholic, the alcohol is in a certain sense so disposed of that it fits, as it were, the body for a long season, nay, becomes part of it; and yet it is silently doing its fatal work; all the organs of the body are slowly being brought into a state of adaptation to receive it and to dispose of it; but in that very preparation they are themselves undergoing physical changes tending to the destruction of their function and to perversion of their structure. Thus, the origin of alcoholic phthisis, of cirrhosis of the liver, of degeneration of the kidney, of disease of the membranes of the brain, of disease of the substance of the brain and spinal cord, of degeneration of the heart, and of all those varied modifications of organic parts

which the dissector of the human subject so soon learns to observe—almost without concern, and certainly without any thing more than commonplace curiosity—as the devastations incident to alcoholic indulgence.—*Condensed from the Popular Science Review.*

VESUVIUS.

GEOGRAPHERS say there are some two hundred volcanoes on the surface of the earth; of these one is situated on the continent of Europe—Vesuvius. This mountain has had a remarkable history, and is now an object of renewed interest, as it has been again in profound convulsion.

Vesuvius stands about 10 miles southeast of Naples, in Southern Italy. Seen from the city it is a mountain with two summits. That on the left is the peak of Somma, 3,747 feet above the sea; the peak on the right being the volcano itself, about 200 feet higher. Between the two summits is a valley at the entrance to which, on a plateau, is situated the Hermitage and the Observatory. The mountain stands on the plain of Campania, and has a base of some 30 miles in circumference.

Vesuvius was an active volcano in very ancient times, and then was in a state of repose for a long period. This is inferred from the fact that writers before the Christian era never alluded to it as in eruption, but do refer to the igneous character of its rocks, and to its "many signs of having been burning in ancient times." It awoke to great activity A. D. 79, and from that time to the present has been the scene of about sixty grand eruptions.

The sides of the mountain, as described by Strabo, were clothed with gardens and vineyards filled with luxuriant vegetation; beautiful farms and rich woods extended to its top, which was flat, barren, and slaggy. Its dangerous character was not suspected: villas were scattered over the sloping landscape; the cities of Herculaneum, Pompeii, and Stabiæ, were planted at its base, and were fashionable resorts for wealthy Romans.

A premonition of what was coming occurred in the year A. D. 63, in the form of a violent earthquake, which overthrew many houses; but its significance was of course not understood, and the houses were rebuilt.

The first great recorded eruption of Mt. Vesuvius occurred August 24th, in the year 79, and has been described by the younger Pliny in a letter to Tacitus. His uncle, the elder Pliny, was at the time in command of the Roman fleet at Misenum, and his nephew was with him. From this point they first descried the eruption. Rising from the top of the mountain they saw what appeared like a column of dense, black

smoke, but which was in reality a mass of dust, ashes, stones, and vapors, the form of which was likened by Pliny to a tall pine-tree throwing out great branches at its top.

Struck with surprise at the new phenomenon, the elder Pliny, a man of philosophical mind, hastened to the shore, that he might examine it more closely. He disembarked at Stabiæ, and went to the house of his friend Pomponianus. Here he remained till evening, gazing at the spectacle, and trying to quiet the fears of those around him. The streaks of fire on the mountain he attributed to the burning of the woods and villages, and when he became weary of the spectacle retired to bed and fell asleep. Meanwhile the shower of stones increased fast in Stabiæ, and began to fill the streets and the courts of the villa. Pliny's servants became alarmed and aroused their master, who joined his friend Pomponianus and his assembled family. What follows is best described in the graphic words of the younger Pliny:

"They took counsel together as to whether they should shut themselves in the house, or whether they should betake themselves to the fields, for the houses were so shaken by the violent tremblings of the earth, which followed each other in quick succession, that they seemed to be torn from their foundations, turned to every point of the compass, and then brought back to their places. On the other hand, they feared outside of the city the falling stones, though they were light and dried up by the heat. Of these two perils they chose the latter. With my uncle the strongest reason prevailed over the weakest. In the minds of those who summoned him, one fear prevailed over another. They fastened pillows around their heads as a sort of shield against the falling stones. Day was breaking elsewhere, but around them the darkest night reigned, though lighted up by the conflagration, and all kinds of fires.

"They approached the shore in order to attempt to escape by the sea, but it was stormy and contrary. There my uncle lay down upon a blanket and asked for some cold water, of which he drank twice. Very soon the flames, and a sulphurous smell which preceded them, put every one to flight, and forced my uncle to get up. He rose, supported by two young slaves, and instantly fell dead. I suppose that the thick smoke arrested respiration and suffocated him. He had a naturally narrow, weak chest, often panting for breath.

"When the light reappeared—three days after the last that had shone for my uncle—his body was found uninjured, the clothing undisturbed, and his attitude was rather that of sleep than of death."

The materials ejected from the mountain consisted of scoriæ and ashes, and their quantity far exceeded its own bulk. The shower of ashes, dust, pumice, and stones, continued to fall for eight successive days, accompanied by torrents of rain, and the cities of Stabiæ, Herculaneum, and Pompeii, were entirely buried. Pompeii was situated several miles farther from the crater than Herculaneum, and was buried only in ashes and loose stones; while Herculaneum was entombed deeper, and in a much more consistent substance, which was evidently plastic, and appears to be composed of volcanic ashes cemented by mud.

The volcano then rested 124 years; the second eruption taking place A. D. 203; and the third, which was much more violent, occurred 269 years later, in the year 472. On this occasion the ashes fell over nearly the whole of Europe; they were transported to Constantinople, and even to Egypt and Syria. In 1036 there occurred a violent eruption, during which lava was for the first time ejected.

The eruption of Vesuvius in 1631 was of extreme violence, and was accompanied by great currents of lava, which flowed over the villages at its base on the side of the Bay of Naples. There were at the same time thrown out immense torrents of hot water, which wrought great desolation.

The eruption of 1779 is described by Sir William Hamilton as among the grandest and most terrible of these phenomena. White sulphurous smoke like heaps of cotton rose up in piles four times as high as the mountain, and spread about it to a proportional extent. Into these clouds, stones, scoriæ, and ashes, were projected to the height of at least 2,000 feet. On subsequent days columns of fire shot forth to full three times the height of the mountain. Masses of rock of great size were projected out of the crater, one of which measured 108 feet in circumference and 17 feet in height. Ponton says the jets of lava were thrown up to a prodigious height. A portion of the ashes and stones was drifted away to some distance; but the greater proportion of these, and nearly all the lava, still red-hot and liquid, fell upon the cone, on part of Monte Somma, and into the valley between them. The whole mass which thus fell, still vividly glowing, formed a continuous fiery expanse about two and a half miles in breadth, which, with the lofty column of fire issuing from the top, presented a magnificent but very terrific spectacle. The heat, radiating from this vast glowing surface, is said to have been perceptible at a distance of six miles all around.

In June, 1794, occurred a terrible eruption, which destroyed the town of Torre del Greco. A single stream of lava was estimated by Breislak as containing more than 46,000,000 cubic feet. A vent opened near the bottom of the mountain, 2,375 feet in length and 237 feet in breadth, which became filled with lava, and on the hardening of this presented a dike in every respect similar to the ancient basaltic dikes.

The eruption of 1822 broke up the whole top of the mountain, and formed an elliptical chasm about three miles in circumference, and supposed to be 2,000 feet deep. The principal cone tumbled in, with a terrible crash, on October 22d, and the following evening there began an eruption which lasted 12 days. The internal detonations of the mountain were described as terrific, while the ashes and dust were so great as to produce at noon in the neighboring villages a darkness deeper than midnight.

The eruption of 1855 presented a most imposing spectacle. We

have referred to the valley or ravine between the two mountains, the first descent to which on the side of Vesuvius is a sheer precipice. A great stream of lava, about 200 feet in width, issuing from the crater, took the direction of this ravine, and on arriving at the edge of the precipice fell heavily over it, forming a magnificent fiery cascade about 1,000 feet in height. On reaching the valley beneath, it wended its way through the woods, consuming the trees in its course, and destroying several villages through which it flowed. A grander sight than this cascade of fire must have presented, it would be difficult for the human mind to imagine.

Monnier says that, "since 1850, springs of lava have opened near the base of the cone in the ravine which separates the two mountains; they are seen springing from the lava much as the water of rivers flows from a glacier. In 1855 and 1858 it rolled slowly through the ravine like the Thames in flames. To be really startling, the lava must be seen, not from above, but coming directly toward the spectator, as I saw it in 1855. Then it was no longer a river, but a burning, moving rampart. This wall was at least a mile wide and 20 feet high. It came slowly, irresistibly, covering the ground, burning the trees and houses; you could walk backward before it as a captain does before his company.

"The lava, as it issues from the crater of Vesuvius, is perfectly liquid, and glows with an intense white brilliancy, like that of molten silver; but, as it descends, it begins to cool at the top, and a quantity of broken slag is formed on the surface of the stream, becoming ere long a continuous coating. The speed of the current, very rapid at first, gradually slackens, until, on the level at some distance from the mountain, its progress is scarcely perceptible."

Vesuvius is much more active in modern times than in ancient; several grand eruptions having taken place within the present generation. The recent convulsion has been marked by the usual impressive features, but comparisons with former eruptions must be accepted with hesitation, for, where the imagination is so powerfully affected, and the data are so uncertain, the judgment may be much at fault. The following description of the present display was telegraphed from Naples, April 29th:

"The view of Mount Vesuvius from this city is now the grandest that has been witnessed since the year 1631. Many persons have taken advantage of the panic among the people of the towns which were threatened with destruction, to take whatever goods they could find, and the government has been compelled to order troops to those places to prevent the stealing of abandoned property. In this city the Bourse has closed, and business is almost entirely suspended. The people use umbrellas to protect themselves from the falling ashes.

"A sound as of thunder accompanies the discharges. The wind was blowing in this direction this morning, carrying dense clouds of

smoke and ashes over the city. The ashes were falling in the streets like snow, and reached a depth of two or three inches. The rumbling inside the volcano continued, but no fresh craters have opened, and the lava has ceased flowing.

"Showers of sand have succeeded the rain of ashes which was falling this morning. The eruption is now accompanied by fearful electric phenomena. Lightning darts incessantly from the summit of the volcano, and the quakings of the mountain are more violent and frequent. The thunder is continuous. Burning cinders, stones, and scoriæ, are falling fast and thick in the town of Massa di Somma, which is entirely deserted."

SIR CHARLES LYELL.

SIR CHARLES LYELL is now seventy-five years old. He took his degree in Oxford, in 1821, and commenced the study of law, but, influenced by Dr. Buckland, he soon left it for that of geology. His first original papers on this subject were published in 1826, and the first volume of his great work, the "Principles of Geology," was issued in 1830. He came to the United States in 1841, and again in 1845, and visited many localities for the purpose of scientific observation. He became president of the Geological Society in 1836, and again in 1850, and was honored with knighthood, for his success in science, in 1848.

Sir Charles Lyell not only ranks as the first of living geologists, but his name will always be closely linked with one of the most important stages in the development of the science. He has been a careful and extensive observer, but he has also eminently a philosophic cast of mind, leading him to the elucidation of principles, and he has accordingly done much to place this great science upon the sound basis of inductive philosophy. Of the extent of his labors in the various special departments of geological observation, it is unnecessary here to speak, but there are one or two great doctrines with the introduction of which into the science of geology his name will be connected, and to which it will be desirable here to refer.

In an able lecture before the Geological Society, in 1869, Prof. Huxley recognized three great systems of geological thought, which he denominates *Catastrophism*, *Uniformitarianism*, and *Evolutionism*. The first phase of thought historically was that of catastrophism. Prof. Huxley defines it as follows: "By catastrophism, I mean any form of geological speculation, which, in order to account for the phenomena of geology, supposes the operation of forces different in their nature, or immeasurably different in power, from those we at present see in action in the universe. The doctrine of violent up-

heavals and cataclysms in general is catastrophic so far as it assumes that these were brought about by causes which have now no parallel."

This was the earliest system of doctrine in geology, and was inevitable because of the narrow and false ideas concerning past time. Observation accumulated evidences of vast changes in the earth's crust; it was held that the world is but a few thousand years old; it was therefore concluded that the changes must have been on a stupendous scale, of which we have at present no experience.

There are geologists who still hold to this view, as there were those in the early history of the science who believed in vast time and slow changes. Hutton, in his theory of the earth, in 1795, put forth this advanced principle: "I take things such as I find them at present, and from these I reason to that which must have been." It, however, became the work of Sir Charles Lyell to elucidate and establish this doctrine, by extensive and critical investigations, as a broad and fundamental generalization of geological science. *Uniformitarianism*, or the theory which extends the present rate of terrestrial changes into the past, is a problem of geological dynamics, and involves the study of the totality of forces by which the earth's crust has been altered, and the rocky systems formed.

To work out so vast a subject on the basis of observation and immediate physical data was enough to task the largest capacity, and it is not surprising that Sir Charles Lyell was little disposed to venture into the more speculative questions of the science. Indeed, geologists early insisted on the necessity of limiting inquiry to the changes that have taken place since the formation of the earliest stratified rocks, and crucifying the propensity to pry into the more distant origin of the world. The English Geological Society tacitly forbade these speculations, and of this procedure Mr. Huxley says: "Uniformitarianism, as we have seen, tends to ignore geological speculation in this sense altogether. The one point the catastrophists and the uniformitarianists agreed upon, when this Society was founded, was to ignore it. And you will find, if you look back into our records, that our revered fathers in geology plumed themselves a good deal upon the practical sense and wisdom of this proceeding. As a temporary measure, I do not presume to challenge its wisdom; but in all organized bodies temporary changes are apt to produce permanent effects; and, as time has slipped by, altering all the conditions which may have made such mortification of the scientific flesh desirable, I think the effect of the stream of cold water, which has steadily flowed over geological speculation within these walls, has been of doubtful beneficence."

Mr. Huxley, in common with many other scientists, now holds that the progress of geological thought must carry us beyond uniformitarianism into evolutionism.

But Sir Charles Lyell is the farthest possible from being a narrow-minded partisan. His career offers one of the noblest examples of

candor and sincerity, in abandoning old ground and embracing new views, that is afforded in the whole history of science. In the earlier editions of his works he accepted the current opinions in regard to organic species and the past course of life upon earth, but, after a half-century's study of the question, he became satisfied that these views are untenable, and in the tenth edition of his "Principles of Geology," published in 1867, he gave them up, and adopted the general view represented by Mr. Darwin. This great work he has again revised, and the eleventh edition has just made its appearance. All the later questions of this most interesting subject will there be found most ably and fully discussed. We subjoin the notice of the work just published by the *Saturday Review:*

The great work of Sir Charles Lyell has too long and too authoritatively held its place as a classic in the literature of science to call for, or even to admit, the expression of any estimate of its value. The number of editions it has gone through may be taken as sufficiently attesting the concurrence of public taste and conviction with the appreciative opinion of the more critical class of readers at home and abroad. It may be hoped that the wide and increasing circulation of so valuable a work has had, and is long destined to have, the effect of leavening the mass of educated thought with its sound, careful, and conscientious views of physical truth. While congratulating both the writer and reader upon the issue of the eleventh edition of the 'Principles of Geology,' we feel that our notice of its contents is almost of necessity restricted to those portions of the work in which the author has seen reason to amplify, to remodel, or to correct, what he had advanced in former impressions.

Within the last five years special attention has been drawn to the geological proofs of strongly-marked changes in the terrestrial climate during long periods of time. In face of the additional facts and corresponding theories which have thus divided the minds of geological inquirers, Sir Charles Lyell has seen fit to recast those chapters of his work which treated of the meteorology and climatic history of the earth's surface, with a view especially to insist upon the paramount influence exerted in this direction by the relative distribution and height of the land at successive periods. The balance of argument and research has been such in the mean while as to confirm him more and more in his conviction of the agreement and continuity of the forces at work through all the vicissitudes of the earth's surface, from the earliest to the most recent geological ages. It is hardly necessary, perhaps, to go further back, for the pedigree of the organic forms which for the most part chronicle and attest the laws of succession, than to that Miocene period in whose organic deposits the flora and fauna of all subsequent ages seem to have their ground and root. A superficial view of the local changes of climate which are proved to have taken place might have, and indeed has, induced the belief that causes no longer

operative had been at work in remoter times. The existence of a subtropical Miocene flora near, and probably up to, the North Pole, with remains of the mastodon, elephant, rhinoceros, and cognate mammals as far north as the icy circle, might be taken to point to a revolution of a terrestrial, if not of a cosmical, kind from higher conditions of temperature. On the other hand, the dispersion in a southern direction of erratic blocks, evidently carried by ice-action, and striated or polished by glacial friction, was a proof of a cold climate extending much farther south than that of the present time, invading even the subtropical latitudes. Now, there can be absolutely no room for the hypothesis of any appreciable change, within Miocene times at least, in the total temperature of the earth, either from the sudden outburst of subterranean fires on the one hand, or from general cooling of the earth's mass on the other. At the same time, a large body of both organic and inorganic evidence supports the view that the climate of earlier geological periods, from whatever cause, had over wide regions been in excess of what it now is. Not only in the greater part of the Miocene and Eocene epochs did a vegetation like that of Central Europe in our day extend into the Arctic regions as far as they have been explored, and probably to the Pole itself, but in the Secondary or Mesozoic ages the prevalent types of vertebrate life indicate a warm climate and an absence of frost between latitude 40° north and the Pole, a large ichthyosaurus having been found in latitude 77° 10′ north. Carrying our retrospect back to the Primary or Palæozoic ages, we find an assemblage of plants which implies that a warm, humid, and equable climate extended from the 30th parallel of north latitude to within a few degrees of the Pole, while a still older flora, the Devonian, leads to a similar inference. Such, moreover, is the general resemblance between the whole invertebrate fauna of the Devonian, Silurian, and Cambrian rocks and that of the Carboniferous, Permian, and Triassic series, as to make it clear that a similarity of conditions as regards temperature prevailed throughout the whole of these six periods.

The idea of possible variations in the temperature of space traversed by our globe, started by Poisson, is promptly set aside by considerations long ago advanced by Mr. Hopkins. Nor is there much greater force, as Sir Charles Lyell amply shows, in the effect attributed by others to variation in the obliquity of the ecliptic. The latest calculations of Sir John Herschel conveyed in a letter to our author, in October, 1866, admit the possibility of a deviation of the earth's axis to the extent of three, or even four, degrees on either side of the mean. The sun's rays would thus be disseminated at intervals over a far broader zone than at present, around the Arctic and Antarctic Poles, with a corresponding shortening of the Polar night, and a diffusion of more genial warmth. Yet, on the other hand, a large deduction must be made, as Mr. Meech has shown, for the increased length of path, and the greater amount of atmosphere through which the calorific rays

must pass in very high latitudes, not to speak of the greater prevalence of cloud in regions round the Pole. A truer cause of climatic change is to be sought in the effect of precession of the equinoxes, the revolution of the apsides, and, above all, the eccentricity of the earth's orbit. The great cycle of change due to precession would cause the different seasons of the Northern and Southern Hemispheres to coincide in turn, within 25,868 years, with all the points through which the earth passes in its orbit round the sun. Combining with this movement, that of the revolution of the apsides or "motion of the aphelion," as Herschel named it, reduces this term of years to about twenty-one thousand. Sir C. Lyell's explanation, aided by a new diagram, renders sufficiently clear the effects which would be produced upon climate by the successive phases of precession, especially when combined with increased eccentricity or distance from the sun. The difference between winter in aphelion and perihelion—the range of eccentricity extending, as he has shown, to 14,000,000 miles at some periods, instead of 3,000,000, as now—is set down by Mr. Croll as not less than one-fifth of the entire heat received from the sun. Some slight change in this direction since the year 1248 A. D. has been thought capable of actual proof by M. d'Adhémar, and of being verified by the observations of M. Venetz upon the decrease of Swiss glaciers prior to the tenth century, and their subsequent increase. An admirable table compiled by Mr. Stone shows the variations in eccentricity for a million years before 1800 A. D., with the number of days which would be added to winter by its occurrence in aphelion, which has been followed up for a million years more by Mr. Croll and Mr. Carrick Moore. From these figures there might appear to be a possibility of approximating to a date for the Glacial epoch; and Sir C. Lyell holds it "far from startling" that 200,000 years back might be fixed upon as about the period of greatest cold, when the excess of winter days amounted to 27.7. He had in his tenth edition speculated upon 800,000 or 1,000,000 years as nearer the Glacial epoch, but he feels compelled to narrow the time within the limit at which the principal geographical features of the continents and oceanic basins were approximately assuming their present form. Were the astronomical theory, however, to be relied upon as the basis for the solution of the problem, we ought to meet in the course of palæontological research with a series of Glacial periods perpetually recurring in the Northern Temperate Zone; supposing a large eccentricity by itself sufficient, apart from the coöperation of terrestrial causes, to intensify the cold of high latitudes. But no such evidence of violent revolutions is to be found in the flora and fauna of earlier periods. The continuity of forms, particularly in the class of reptiles, from the Carboniferous to the Cretaceous period, is an obvious fact opposed to the intercalation of intense glacial epochs. Another fact is, that many great cycles of eccentricity must have been gone through in the long centuries of the Carboniferous period, in which no break in the order of life is manifested.

The exhaustion of all other means of solution, joined to the mass of positive evidence accumulated by recent science, throws us more and more conclusively upon the idea to which Sir Charles Lyell has firmly held from the first, and which may be taken as the culminating point of his latest achievements in geology, that the predominant cause of the great changes in climate is to be found in the distribution and elevation of the land. The Glacial period may be traced to an excessive and abnormal accumulation of land around the Pole. There is absolutely no limit to the alternations which the surface of our globe may have, or indeed has gone through. There is hardly a spot of what is now land which has not been covered by the sea, probably not a space now covered by the ocean which has not been at some time, if not many times, dry land. In one epoch the land may have been chiefly equatorial, at another polar or circumpolar. At present we may readily divide the globe into two equal parts, the land hemisphere and the water hemisphere; the former of which exhibits almost as much land as water, or as 1 to 1.106; while in the latter the proportion of land to water, as made out by Mr. Trelawny Saunders, is only as 1 to 7.988. The general proportion of land to sea may be taken throughout the globe as 1 to 2¼. Were the land, by the action of subterranean forces, its total amount being unchanged, now gathered together in masses along the equator and around the Poles alternately, such geographical changes would amply suffice, as Sir C. Lyell makes it his task to show, to explain the utmost vicissitudes which the climate of the earth has undergone. This course of reasoning by no means precludes such aid as may be brought in by independent *veræ causæ*, by the concurrence of the cold period induced by excessive piling of land around the Pole with wintering in aphelion, or at a period when the earth's axis was abnormally inclined. These causes, especially in combination, would greatly intensify what, after all, must remain the ruling and inherent principle of climatic revolutions. We have only to look at the present aspect of Greenland to satisfy ourselves what might become the state of the British Isles by a mere substitution of other local conditions under the same parallel of latitude. Were the Gulf Stream done away with, the equatorial continents which now form vast reservoirs of heat transferred to the Northern regions, and their snow-clad frozen surface swept by Polar currents, how far south would the ice-sheet cover the unsubmerged tracts of land, and the glaciers come down to the level of the sea? The chain of facts and reasonings by which Sir Charles Lyell binds together the phenomena which science and discovery contribute to this intricate problem forms one of the most characteristic features of his book. Every new link, and every additional degree of tenacity given to his argument, enhances the value of this standard work as a steadfast, clear-sighted, and consistent witness to the great law of uniformity and continuity in Nature.

The latest information acquired by deep-sea dredging has been

incorporated by Sir C. Lyell into his remarks upon the temperature and shape of the bed of the ocean and its living inhabitants. In his chapter on ocean-currents he has also considered the latest-known results of experiments and observations made by Dr. Carpenter, Prof. Wyville Thompson, and Captains Spratt and Nares, upon the currents of the Straits of Gibraltar. The space allotted to this survey is not adequate to a full or critical discussion of the arguments for and against the existence of a permanent indraught. The balance of proof, however, is felt by Sir Charles to support his previously-expressed conviction that the inflowing movement is no permanent undercurrent caused by evaporation, but the result of the Mediterranean tide, which, slight as it is, runs alternately from east to west for several hours, its action being found more regular in the depths of the straits, where it is less affected either by winds or by the surface inflow. The difference of no less than twenty degrees between the temperature of the Mediterranean and the Atlantic, as well as the difference of four degrees between the deep-sea soundings of the western and central basins of the Mediterranean and of the Greek Archipelago, is explained by the existence of high submarine crests or barriers of rock bounding the sea to the west, and again dividing it into sections, as shown by the diagram in the present edition. Proceeding to the wider problem of ocean circulation arising out of the extreme cold found at great depths both in temperate and tropical regions, Sir Charles disputes the notion of these low temperatures being due to mere depth, the Mediterranean soundings of 13,800 feet having failed to reach a degree of cold below 55° Fahr. Yet the soundings taken at Aden, whither the cold water can only come from the Southern Hemisphere, lead to the belief that the whole of the equatorial abysses of the ocean are traversed, in some parts at least, by a continuous mass of water not much above 32° Fahr. That solar heat is in some way or other the primary cause of this great displacement, through the change in specific gravity from the cooling of water toward the polar zones, counterbalanced by a return, however slowly, of water from the equator to the Poles, may well take the place of more recondite theories, such as that exploded by Herschel, that the expansion of water by heat in the equatorial zone raises the level of the sea, and causes a flow down a gently-inclined plane toward the Poles. In the absence, however, of more extensive and accurate knowledge of the state of the ocean at great depths, or of its local direction and quantity of motion, in relation to the utter stillness found generally by the sounding-line to prevail in its great abysses, Sir Charles Lyell is too cautious and patient a reasoner to think the time ripe for a positive solution.

EDITOR'S TABLE.

LOOSE AND ACCURATE KNOWLEDGE.

IN explaining what we understand by science, in the first number of this monthly, it was stated to consist in accurate as contrasted with lax and careless thinking. We had not then space to show how a great deal of the knowledge that is truly recognized as scientific may be still so loose and imperfect as to be misleading. Let us, therefore, briefly consider this aspect of the case.

There are two stages in the history of science, and two states of mind among so-called educated people, which correspond to them. The first stage of all science consisted simply in recognizing the properties of bodies so as to identify them. The characters were made out which distinguished this thing from that, and one kind of effect from another. The first thing was to determine the *qualities* of objects, and this was the work in the early or *qualitative* stage in the progress of each science. But, qualities being ascertained, the next and inevitable step was to bring them under the operation of mathematics, which deals with the laws of quantity. First, it was asked, What are the properties or effects? and next, What are their degrees, or what quantities are involved in given results? This implies exact measurement, and is known as the *quantitative* stage of science.

For example, bodies, which burn and produce heat, have the property of combustibility; but the next question is, *How much* heat will different bodies produce in burning? It is a quality of vinegar to unite with soda, and this was ascertained in the qualitative infancy of chemistry, but how much vinegar will combine with a given amount of soda was only determined with the development of quantitative chemistry. It is a quality of animals that they exhale carbonic-acid gas in respiration, but, when this was known, it became necessary to know the rates of exhalation in the different tribes, and the variations of these rates in sex, age, activity sleep, and disease. It is a quality of ideas that they cohere with each other, forming groups and trains by which thinking becomes a connected and orderly process; but it is also a fact that these cohesions are of unequal degrees of strength, and this gives rise to a kind of quantitative psychology, which is only imperfect because we lack the means of exact measurement.

Now, qualitative information is the first indispensable step in the growth of knowledge, and is just as truly "science" as the knowledge of quantities; but it is not the whole of science. Qualitative chemistry must precede and underlie quantitative chemistry, and so with other departments. But, to suppose that a mere knowledge of qualities may pass for science is an error leading to the worst practical consequences. Current scientific knowledge, however, is very much of this qualitative sort. As it was first in the order of development, because it is simplest, it is also most widely diffused for the same reason. This is one of the things that is meant in saying that people think vaguely and loosely, and reason wildly, upon subjects in which science is involved. For every thing in practical and applied science turns at last on the question, How much? It is not enough to know that a given substance will produce a given effect; we must know the degree or amount of effect before we can build upon it. It is this scientific smattering with qualitative notions that exposes people to all forms

of plausible imposture. The skilful knave, with his new process and patent-right, practises on this half-knowledge of the community, and enriches himself at the expense of his victims. He is very candid, and would have them take nothing on trust. He will bring his idea to the test of experiment. They shall see for themselves, and need take nobody's word. "This arrangement will produce such an effect. I don't ask you to accept my statement, I will demonstrate it;" and with an impressive parade of fixtures, and much scientific talk, the alleged wonderful things are done. With those who have not thoroughly learned that every thing depends not upon effects produced, but upon their *quantities*, the next step of the unscrupulous patent-agent is easy. Having established himself in his customer's confidence, he does the rest by profuse asseveration and persistent lying. "The facts are proved; it is a new discovery; it will revolutionize the business, and somebody is going to make enormous profits—you had better have some of the stock." But the skilful speculator may go still further. If sharply met by the question of economy, or exactly how much is gained by his process, he may proceed to prove his claim on the spot. He may demonstrate experimentally and completely that his operation has the advantage by many per-cent. over those in use, while the project is still a worthless fraud: for it is possible in a small way, and with careful experiments, to produce quantitative results which cannot be realized on the manufacturing scale.

There is no end to the schemes that are palmed off upon the public in this way. A morning paper that has just come to hand has the following item:

"Will water burn? And, if so, can burning water be used at a moderate cost for fuel? The public mind of Peoria, Ill., has been of late much exercised upon these questions. A stranger and a Yankee came to the city and claimed that, by burning mixed water and oil in it, he could heat a common cooking-stove red-hot in five minutes. The proportions were four gallons of oil to five gallons of water, and with this quantity the inventor declared that he could run a steam-engine for thirty days, heat twelve furnaces, or light a whole city with gas. The oil was worth 50 cents a barrel, and cooking, heating, and lighting, were thus to cost almost nothing. A stock company was started to push the enterprise, and it was found that 'by the aid of twelve gallons of oil two gallons of water could be evaporated.' It didn't promise overwhelming dividends. The corporation disembodied itself as fast as possible, and the inventor, packing up his gas-pipes and oil-cans, left Peoria, to enlighten and warm some other region."

How true this statement may happen to be, we do not know; but we do know that analogous cases are abundant.

These consequences are a natural result of superficial scientific teaching. A little science is now dispensed in all schools; but it is generally the qualitative rudiments that are easiest taught, and which serve only to make pedants of the pupils. A mass of the simpler facts are memorized as mere sensational acquisition, and there is very little training in principles, or scientific method. It is not to be expected that in general education students will possess themselves of all the higher qualitative data of science, so as to be able to meet any emergency with ready and accurate information. But, for protection from such impositions as we have here noticed, there should be such a cultivation of the scientific judgment as will guard against the grosser fallacies put forth by unscrupulous projectors.

THE QUESTION OF STIMULATION.

THE article in our present number, on the physiological position of alcohol, by Dr. Richardson, an eminent physician of London, is the freshest exposition of the subject yet offered. Its

author has made narcotics and anæsthetics a matter of special scientific study and physiological experiment; and, although his hypothesis of a "nervous ether" is regarded as fanciful, yet his statement of the way alcohol influences the system is independent of that speculation, and will be found instructive.

The evils that arise to individuals and to society, through the agency of alcoholic drinks, are universally admitted, but the question what is to be done to remedy them proves most difficult. It has been asked in this country and in England, for half a century, without eliciting any satisfactory reply, and the same question is being now very seriously proposed by the French. There seems to have been an enormous increase in the consumption of spirits in France, a great reduction of cost, and a deterioration of quality. In 1820, there were consumed 7,700,000 gallons of alcoholic drink; in 1869, it had risen to 21,500,000 gallons. In 1850, nine-tenths came from the distillation of the products of the vine, while in 1869 the vine furnished only three-tenths of it —the remainder coming from beet-root and grain. So a gallon of liquor, which in 1850 cost nine francs, sells to-day for two and a half francs. It is alleged that suicides and insanity have increased during this period in a rapid ratio.

To arrest this tendency of things, the French are fertile in projects. They would tax cheap liquors, they would extirpate the vine, they would make public drunkenness criminal, they would pledge men to total abstinence from—ever setting foot in a *café*.

But, what is more to the purpose, a society has been organized in Paris, embracing a large number of physicians and scientists, who propose to instruct the people by the press and lectures as to the evils which flow from the habitual use of alcoholic drinks. They will not insist on teetotalism or prohibition, but urge the substitution for the stronger liquors of such beverages as coffee, native wines, cider, and beer.

It is not to be disguised that the problem here proposed, and with which civilization is now confronted, is one of the most refractory that philanthropy has yet encountered. Slavery was a local and anomalous institution, based upon legislation, and, when the turf of moral suasion failed to dislodge it, the stones of war proved effectual. But the evil of intemperance cannot be terminated by burning gunpowder. The craving for stimulation and for stimulants, in one or another of their innumerable forms, is not a local, unusual, arbitrary, or statutory thing, but a rooted and universal passion of human nature. It is not confined to special communities, but pervades alike the civilized and uncivilized races all over the world; varying in different types of humanity, but common to all. Some races take to opium, others to hashish, others to alcohol. It is this deep basis of the propensity in human nature that gives to the subject its mystery and its perplexity.

The *rationale* of stimulation is indeed not so puzzling. Food builds up and maintains the vital activity of the whole animate creation in its working state, but that is not enough for man. He leads a life of high and complex feeling, subject to wide fluctuations, while his intellect furnishes him with the means of influencing his emotional states. He therefore seeks those agencies which act to arouse pleasurable emotion, and these are stimulants. Capable of appreciating the immediate pleasure, but incapable of realizing adequately the distant pain, the habit is formed, and use runs into abuse.

What, then, is to be done? Here logic is soon at fault, for the headlong reformer, who fixes his attention upon some special phase of the evil, and would eradicate it root and branch, is soon found to be himself involved in something not very unlike what he so

zealously condemns — he, too, is an object of reformatory solicitude. One thunders against the whole tribe of alcoholic stimulants, from ethereal wine to acrid whiskey, and never touches, tastes, or handles them—the pipe will do for him. Another counter-blasts tobacco—content with abundance of strong coffee. Another decries all these together, inspired by the stimulus of concentrated potions of tea. Still another ingests perhaps only vegetables and water, and fulminates from the pulpit or platform against all these gross material indulgences, yet is lifted into the seventh heaven of enjoyment by the stimulating incense of flattery and applause which comes up from admiring auditors, and without which life would be "flat, stale, and unprofitable." Others get from music, pictures, theatres, fashion, novels, newspapers, or travel, a quieter form of excitement, which, though often running into dissipation, is less harmful than ordinary narcotic stimulation. How far the ball-room, the political campaign, or the religious revival, may be the equivalent of a drinking spree, we will not pretend to say, but that they are all marked by a common character—stimulation of pleasurable feeling carried to a pitch of excitement which ends in reaction more or less exhausting—is not to be denied.

As regards relief from the mischiefs of over-stimulation, alcoholic or otherwise, we have no reformatory nostrum to propose. And, when they are proposed, we shall do well to remember that the evil does not exist alone; it is part of the general imperfection of our nature, and the social state which accompanies it. Nor is it to be remedied alone; the evils that result from the craving for stimulants, and the gratification of it by dangerous drugs, will probably only be removed with the slow and general improvement of character and amelioration of social conditions. As soon as people know better their own nature and the true conditions of its unfolding, and begin to regard the subject with a more sacred respect, in proportion, we will venture to say, to the growth of a *scientific conscience*, will man become a higher law to himself, and the grosser vices of conduct may be expected gradually to disappear.

LITERARY NOTICES.

CORALS AND CORAL ISLANDS. By James D. Dana, LL. D. Dodd & Mead.

THIS book will be widely welcomed, not only for the interest of its matter and the elegance of its form, but because of the gratifying assurance it will afford to the numerous friends of its accomplished author that, although in shattered health, he still retains that wonderful power of versatile labor by which he has been distinguished in the world of science for the last 25 years. Prof. Dana went round the world, from 1838 to 1842, with the Wilkes Expedition, as geologist in the scientific corps. In this extended exploration, in addition to his geological work, he made a special and elaborate study of the zoophytes, and treated at length of corals, coral animals, and coral reefs. His reports upon these subjects were, of course, designed mainly for men of science, but in the present volume he has recast the statement, with the view to its more general usefulness. In his preface the author says: "The object in view, in the preparation of this work, has been to present a popular account of 'corals and coral islands,' without sacrifice of scientific precision, or, on the main topic, of fulness. Dry details and technicalities have been avoided as far as was compatible with this restriction; explanations in simple form have been freely added, and numerous illustrations introduced in order that the subject may have its natural attractiveness to both classes of readers." The object proposed has been very completely attained, and a volume produced which will be alike valuable to men of science and entertaining and instructive to general readers. Its illustrations are many and fine, and its manufacture is a credit to the publishers.

We have no room here to treat of the

contents of Prof. Dana's volume, but mean to do so in a future number; yet we cannot forbear quoting a pleasant passage referring to a man of whom much is now vehemently said, both in praise and disparagement:

"Our cruise led us partly along the course followed by Mr. CHARLES DARWIN during the years 1831 to 1836, in the voyage of the Beagle, under Captain Fitzroy; and, where it diverged from his route, it took us over scenes, similar to his, of coral and volcanic islands. Soon after reaching Sydney, Australia, in 1839, a brief statement was found in the papers of Mr. Darwin's theory with respect to the origin of the atoll and barrier forms of reefs. The paragraph threw a flood of light over the subject, and called forth feelings of peculiar satisfaction, and of gratefulness to Mr. Darwin, which still come up afresh whenever the subject of coral islands is mentioned. The Gambier Islands in the Paumotus, which gave him the key to the theory, I had not seen; but on reaching the Feejees, six months later, in 1840, I found there similar facts on a still grander scale and of more diversified character, so that I was afterward enabled to speak of his theory as established with more positiveness than he himself, in his philosophic caution, had been ready to adopt."

SPECTRUM ANALYSIS, in its Application to Terrestrial Substances, and the Physical Constitution of the Heavenly Bodies. Familiarly explained by Dr. H. SCHELLEN, Director der Realschule I. O. Cologne. Translated from the second enlarged and revised German edition, by Jane and Caroline Lassell. Edited, with Notes, by William Huggins, LL. D. With numerous Woodcuts, Colored Plates, and Portraits; also, Angström's and Kirchhoff's Maps. 455 pages, 8vo. D. Appleton & Company.

IN his late work on the sun, Mr. R. A. Proctor, author of "Other Worlds than Ours," says: "The reader is referred, for fuller details than there is here space for, to Dr. Schellen's work on 'Spectrum Analysis,' the English edition of which is now preparing for publication under the able supervision of Dr. Huggins. This work will be specially worthy of very careful study in all matters relating to the spectral analysis of the sun." This long-expected work, which has been so eagerly looked for by those who desire a popular and authoritative exposition of this beautiful subject, has now appeared, and is republished in this country at half the English price. An able writer in the London *Spectator* thus speaks of it:

In the whole history of science there is nothing more wonderful than the discovery or invention (it would be difficult to say which is the more correct term) of spectrum analysis, and the sudden advance of the new method of research into a foremost position, among all the modes of scientific inquiry. If we take up at random any recent scientific work, whether on astronomy, or chemistry, or meteorology — nay, even though it treat of subjects like entomology, botany, and conchology, which seem as far as possible removed from optical problems—we cannot turn over its pages without finding more or less copious reference to the prismatic analysis of light. Yet, thirteen years ago, spectrum analysis had no existence whatever as a mode of scientific inquiry. It was a subject for research, not a method of research, and there were not a few who regarded it as a subject altogether intractable, while scarcely any believed that it would become the means of advancing our knowledge to any important extent.

The history of the sudden advance of this great problem into the position of a great solver of problems is full of interest. Not five years had passed from the day when Kirchhoff announced the true meaning of the dark lines in the solar spectrum, before Huggins and Miller were telling astronomers of the terrestrial elements existing in the stars. Then the great secret of the gaseous nebulæ was revealed by Huggins, and soon after the structure of comets began to be interpreted. Nor had chemists been idle in the mean time. In 1861, Bunsen and Crookes by means of the new analysis, had detected three hitherto unknown elements, cæsium, rubidium, and thallium, and, in 1863, Reich and Richter had discovered a fourth new element, indium. The importance of the new mode of research in all problems of chemical analysis, as a delicate test for determining the presence of poisons, as a means of im-

proving many processes of manufacture, and as an aid in almost every branch of scientific inquiry, became each year more clearly recognized. We have seen Sorby analyzing by its means the coloring-matter of plants, and the entomologist comparing the spectrum of the glow-worm and the fire-fly, or discussing the absorption-bands peculiar to the fluids of insects. The microscopist employs the powers of the new analysis to solve problems which the magnifying powers of his instruments would be altogether unable to cope with. Nothing, in fine, seems too vast or too minute, too distant or too near at hand, for this wonderful instrument of research, which deals as readily with the mass of Sirius, a thousand times larger and a million times farther away than our sun, as with the ten-thousandth part of a grain of matter in a flame within a few inches of the spectroscopic tube.

It is, perhaps, not the least wonderful circumstance about the new analysis that it has already been made the subject of many volumes of scientific lore. A goodly library might be filled with the printed matter which has been devoted to spectroscopic analysis, either in works definitely directed to the subject, or else in chapters set apart for its treatment in works on other subjects. But the general public has undoubtedly not had occasion to complain, as yet, that the analysis has been too fully expounded to them. It cannot be denied, indeed, that hitherto the vaguest possible ideas have been entertained by many respecting the most powerful mode of scientific research yet devised by man. The work of the telescope or of the microscope all men can at once understand, even though the principles on which these instruments are constructed may not be thoroughly understood save by a few. But the case is very different with the work of the spectroscope. When the astronomer says that with a telescope magnifying so many times he can see such and such features in Mars or Venus or Jupiter, every one knows what he means; but, when the spectroscopist says that his instrument shows certain bright lines in the spectrum of a nebula, or certain dark lines in the spectrum of a planet, the general reader has to accept on trust the interpretation placed on such results by the observer.

It was to remove this difficulty that the present volume was originally written. Of its value in this respect we can have no higher evidence than the fact that Dr. Huggins named it to the two ladies who have translated the present edition as 'the best elementary work on spectrum analysis.' The translators—the Misses Lassell (daughters of the eminent astronomer who has just vacated the presidential chair of the Astronomical Society)—remark that the interest they derived from the perusal of this work 'suggested the idea of undertaking its translation.' Dr. Huggins agreed to edit the volume; and, accordingly, we find appended to the valuable text of Dr. Schellen many important (in some cases absolutely indispensable) notes by the English master of the subject.

The work thus translated is from the second German edition, which is not only much larger than the first, but is improved by the correction or omission of several faulty passages. It consists of three parts. The first describes the various artificial sources of high degrees of heat and light. The second relates to the application of the analysis to terrestrial substances. These portions of the work are extremely important, and, on the whole, they are well arranged; but, to say the truth, they are rather dry. Fortunately for the general reader, they occupy together little more than one-third part of the work, the remainder being occupied by the description of the application of spectrum analysis to the heavenly bodies. In this, the third section of the book, we have four hundred pages full of the most interesting matter. The investigations of astronomers into the nature of the sun's globe, and of those wonderful envelopes which surround him, are described with great fulness of detail, and illustrated by a fine series of drawings. The colored plates, representing the prominences as seen by Zöllner, Respighi, and Young, are especially interesting and suggestive, more particularly when the reader's attention has been directed to the scale of miles—or rather of thousands of miles—placed under each. Respighi, indeed, rejects mile-measurement altogether, and can be satisfied only by a scale of terrestrial diameters; so that, instead of showing how many thousands of

miles would correspond to the height of the colored prominences, his scale tells us how many globes as large as our earth could be placed one above another, so as barely to reach to the summit of the solar flames.

The sections on the stars and nebulæ are full of interest, though Dr. Schellen is disposed to place somewhat more reliance on the researches of F. Secchi into the stellar spectra than is entertained by our leading spectroscopists. On dealing with meteors and their spectra Dr. Schellen lays a well-deserved stress on the labors of Schiaparelli, to whom science owes the recognition of the strange fact that meteoric rings are associated with comets. Nearly ten years have passed since Schiaparelli announced that 'the comet of 1862, No. III.' (a large and bright object) 'is no other than the remains of the comet out of which the meteoric ring of the 10th of August has been formed in the course of time.' Received with doubt for many months, this bold assertion gradually commended itself more and more to the attention of those who studied meteoric phenomena, until in 1866 the recognition of a corresponding agreement between the November meteor-ring and Temple's comet of that year removed all doubt as to the reality of the relation. On February 9th of the present year, the gold medal of the Astronomical Society was awarded to Schiaparelli in recognition of this important contribution to our knowledge.

The editorial work of Dr. Huggins adds considerably to the value of Schellen's treatise. In places, the author apportions somewhat incorrectly the merit due to various workers in the field of spectroscopic research; so that some of the notes in which Dr. Huggins refers to these points are, in reality, very necessary. But the work of the editor is yet more important in removing errors and explaining difficulties relating to scientific details.

ANCIENT AMERICA: in Notes on American Archæology. By John D. Baldwin, A. M. Harper & Brothers.

ONE of the great results of modern science is the power it confers of arriving at true interpretations of the past. Just in proportion as it discloses orderly relations in the events of Nature, and trains the human mind in the careful weighing of evidence, it enables investigators to turn backward and gather a knowledge, which was before impossible, of the ancient order of things. We owe to science, therefore, a history of man which is earlier than books—of civilizations which rose and passed away with no literature to preserve its memory. Fragmentary and most incomplete it assuredly is, and a host of questions arise in the inquirer's mind to which no answers can be given; yet a vast and constantly-increasing mass of facts is known, from which many valid conclusions are deduced of interest to the students of Nature and of Man.

Archæology, or the science of antiquities, searches for all the vestiges of human action in the distant past; the remains of architectural structures, of public works, carvings, inscriptions, coins, medals, heraldic symbols, workmen's tools, articles of use and ornament, and whatever can serve to throw light upon the state of man and society when they were produced. It matters nothing how apparently trivial are the relics of by-gone ages; they have interest for the archæologist because they are the results of art, industry, intelligence, and social organization, and become the measures of these conditions.

The book before us treats of the most interesting departments of American archæology. Its author published a volume in 1869 on the prehistoric nations, and now follows it with a popular compendious statement of what is known of the ancient monuments of North and South America, and the inferences they warrant as to the condition of the early inhabitants of our continent. For, whatever theory is adopted regarding the origin and career and relationship of the American races of men, one thing is certain: this continent was formerly the theatre of a people greatly superior to the Indian tribes. Many of the works that remain give evidence of high, though of course, indefinite antiquity.

One of the phases of ancient works which remain to us in great abundance is the mound-structures; the people who made them being known as the mound-builders. These are numerous in the Mississippi Valley—there being 10,000 of them in Ohio

alone. One, in West Virginia, is 70 feet high, and 1,000 feet in circumference. They are truncated, and their summits are supposed to have been occupied by edifices—probably temples which have disappeared. Lines of artificial embankments remain which enclose from 100 to 400 acres, and evince a considerable degree of geometrical knowledge in their plans. Many articles, as vases, pottery, fragments of cloth, and copper implements, have been found in them, indicating considerable industrial skill. There is evidence that, since they were built, the rivers have changed their courses, and it is also a significant fact regarding their antiquity that the human skeletons found within them are in a state of decay so advanced that they crumble to pieces as soon as touched. Skeletons found elsewhere, and known to be 2,000 years old, are still compact, and comparatively well preserved. An interesting fact in regard to these aborigines is, that they knew something of mining. In the copper-mines of Lake Superior, old excavations for the extraction of the metal, 30 feet deep, have been discovered. Mining implements were found in the cavern, and trees 400 or 500 years old (as ascertained by counting their annual rings) stood upon the *débris*. Prof. Newberry, Geologist of the State of Ohio, informs us that he has found evidence of the ancient working of oil-wells and lead-mines.

The indications of civilization in Central America, Mexico, and Peru, are still more perfect. The author states that the great Peruvian roads of stone, lime, and cement, 25 feet wide, and with a strong wall on each side, and carried over rivers, marshes, and mountains, and as long as both our Pacific Railroads, make these boasted works of the nineteenth century dwindle into insignificance.

Mr. Baldwin's book is neatly and copiously illustrated, and it has the excellent defect of being too brief.

PROF. TYNDALL'S NEW BOOK.

The first volume of the "International Scientific Series" will be by Prof. Tyndall, on the "Forms of Water," and will treat of the mutations of this element in the great operations of Nature, especially in the phenomena of glaciers. We publish a short article from the advanced-sheets, which will give an idea of the lucid simplicity of the style in which it is written. Prof. Tyndall throws his statements into the direct colloquial form, as if he were talking to a young student beside him, and *showing* him the things he is talking about. There is true art here as well as science—the art of forcible, effective, vivid presentation by which words become pictorial to the imagination. Prof. Tyndall is as skilful in his manipulation of language as of his scientific apparatus, and he sets his successors in the International Series an example which it will be not easy for them to imitate.

While speaking of Prof. Tyndall, it may be proper to add that he intends visiting the United States in the autumn, perhaps early in October. He will come to see his friends (and he will find them numerous), and to get acquainted with our people; but it is not his purpose to exploit the country as a lecturer. He may probably give a few lectures, but he will embarrass himself by no previous engagements.

MISCELLANY.

CONCERNING ATOMS.

Dr. S. D. Tillman publishes in the *American Chemist* an able paper on "Atoms and Molecules," in which he reviews the present state of the question, and gives the reasons why we should still hold by the atom, notwithstanding the attempts made to get rid of it. Both sides of the question were early taken, on purely speculative grounds. The ancient philosophers, in their subtle reasonings on the constitution of Nature, asserted the existence of ultimate indestructible material atoms. Others, and notably Boscovich, at a later day denied the material atoms, and substituted for them what he termed centres of force. Modern chemistry, however, approached the subject from a different point of view. It was proved that the interior changes and reactions of matter are governed by definite mathematical laws, and it was inferred that material substances must therefore be made up of ultimate material units. The assumption was made, because it best explained

the laws of chemical change. Still the tendency to resolve matter into force continues with many, who of course abandon the conception of atoms, and the theory that implies them.

Dr. Tillman shows that the facts of invariable weight which experiment establishes, of equal or multiple gaseous volumes, of specific capacities for heat, of the equilibrium of chemical forces, of isomeric transformations, and of uniformity, homogeneity, and constancy of structure, in the constitution of material substances, are all explicable only by the conception of indivisible and indestructible atoms.

WHAT BECOMES OF COMETS?

Prof. G. B. Donati, whose name is already famous in connection with comets, has just issued a paper on this subject from the Royal Observatory of Florence, which appeared in the *Evening Post* in full, and of which the following is the substance: He denies that any astronomer has recently seen a large comet, and affirms that none at all are visible at the present time. As for new comets, no astronomer can tell whether they will or will not appear. As to periodical comets, that of Biela, which completes its circuit round the sun in six years and nine months, is due next August. The earth and the comet of Biela travel different ways, and their paths cross each other at a certain point. A collision is, therefore, not impossible. The comet and the earth have, however, hitherto passed the point in question at very different periods. Should Biela's comet arrive, it would traverse the terrestrial orbit on August 26th; but on that day the earth would be distant from the comet almost half as far again as it is distant from the sun. As to whether any other comet may encounter the earth, Prof. Donati holds it to be possible, but infinitely improbable. "The comets," he says, "have masses so small that, if one of them were to approach to within even a short distance from the earth, the latter perhaps would have nothing to fear, and, in all probability, in such an event, the comet would become a satellite of the earth." As for the comet of Biela, he says there is great probability that it no longer exists; although it should appear every six years and nine months, it has not been seen since 1852. From 1826, the time of its discovery, to 1852, it appeared regularly. In 1846 the comet presented a most extraordinary appearance. Instead of appearing single, as was the case on all preceding occasions, it appeared double—that is, composed of two parts, separated by a distance of more than 100,000 miles. When it appeared in 1852, the separation was still more complete, the interval amounting to 1,200,000 miles. Its non-appearance in 1858 was attributed by some to its immersion in the solar rays; but in 1866 it should have reappeared in a position so far from the sun, that it would have been visible at night; but it was impossible to discover it. Nor is the comet of Biela the only one which has failed to appear when due. That discovered by Prof. De Vico at Rome in 1814, and which should return every five and a half years, has never since been seen. What becomes of them? Kepler held that they may be dissipated, and said that as the silk-worm consumes itself while spinning its cocoon, so comets may consume themselves, and die while generating their long, interminable tails; and Newton thought that they might fall directly into the sun. But Donati conjectures that the material of Biela's comet has already fallen in part, and is still falling upon our planet. Prof. Schiaparelli, who has just got the gold medal of the London Astronomical Society for his study of comets, maintains that they are resolved into shooting-stars—meteors which traverse the earth's atmosphere. It is well known that on August 10th and November 13th many such falling stars are seen; and this is explained by supposing that the earth passes through two great belts or bracelets of meteoric matter, and draws some of the fragments or corpuscles toward itself. Prof. Schiaparelli has demonstrated that there are several comets which move round the sun, in the direction of these meteoric bracelets; and Prof. D'Arest has noticed that every year, on December 5th, shooting-stars are seen that irradiate from that part of the celestial dome in which the comet of Biela would appear, if it came at all. It seems probable that the comet of Biela forms part of a bracelet of cometic corpuscles which move

round the sun. It may have here been exposed to a mechanical influence, which broke it into two parts, and it is quite possible that many other breakings may have taken place, reducing it to fragments so small as not to be visible, except as falling meteors.

FISH AS FOOD.

Those fish are most digestible which have least of the oily element in their composition. Rich or fatty fish are apt to disturb the stomach, and prove stimulant to the general system. Thirst and an uneasy feeling are frequently produced by them, and it is this, doubtless, that has led to the practice of drinking spirits with this class of food. Hence, the proverb, "Brandy is the Latin for fish." It is well, therefore, in selecting fish, to choose those that cook dry, and are freest from oily matter. The sooner a fish is cooked, after being taken from the water, the better it will be. There is a popular notion that, like butchers'-meat, fish is improved by being kept awhile before it is fitted for the table. This is a mistake. There is a white curdy matter, plainly visible between the flakes of freshly-boiled fish, which adds much to the flavor, and is highly nutritious. This is really a film of albumen, produced by the coagulation of the serous juices, contained in the muscles. If the fish is kept long before cooking, a large share of this is lost, and the flavor of the fish correspondingly impaired. Fishermen themselves say that fish, taken directly from the net to the kettle, are as different, in flavor and nourishing properties, from fish one, two, or three days old, such as are purchased in our markets, as "chalk is from cheese."

By drying, salting, smoking, and pickling, the digestibility of fish is greatly injured, though in some cases its savory and nutritive properties may be improved. The flesh of fish is more digestible boiled than fried, and for invalids should always be cooked in this way. That of the male fish is in most cases better eating than that of the female; and, in either case, it is at its greatest perfection for food at the period of the ripening of the milt or roe. After spawning-time, fish appear to get out of condition, their flesh becomes soft and flabby, loses flavor, has a bluish semi-transparent look after cooking, and eaten thus is sometimes productive of much evil.

If lobsters and crabs are fresh, well cooked, and eaten in reasonable quantity, they agree with most stomachs, though less digestible than fish. They sometimes, however, produce violent colic, nausea, giddiness, depression, and nettle-rash; these effects depending upon some peculiar susceptibility of particular persons. Lobsters are frequently sold insufficiently boiled, and in this state are not nearly so wholesome as when thoroughly cooked.

Of all bivalves that are eaten, oysters are the most easily digested, and the most nutritious; and they are more digestible raw than cooked. Cooking coagulates and hardens the albumen, and corrugates the fibrine, causing both to be less easily dissolved by the juices of the stomach. Raw oysters rarely disagree even with invalids or dyspeptics. Persons of a gouty habit, however, particularly if they have dyspepsia, are sometimes violently disordered by them; and they have been known to bring on convulsions when eaten by women soon after confinement.

Many of the sauces eaten with fish are very indigestible compositions, and often the fish itself is charged with ill-effects which are solely due to the sauce. Oyster-sauce is too often made so badly, that both sauce and oysters are unfit for food.

Fish is less satisfying to the appetite than meat, poultry, or game, and, as it contains a larger proportion of water, is obviously less nourishing. On the other hand, many persons pass through the season of Lent on a diet composed almost wholly of fish, without apparent diminution of strength; and whole villages may be found on the coast, where fish almost entirely takes the place of butchers'-meat, the inhabitants at the same time being noted for their health and vigor.

TEMPERATURE OF THE BODY IN HEALTH.

In the healthy human adult, the body being at rest, and the temperature of the surrounding atmosphere about 60° Fahr., the average temperature in the axilla is 98.-4°, in the rectum 99.4° and that under the tongue is intermediate, or about 98.9°. The

average healthy temperature is not absolutely identical in every individual, but may vary from 97.75° to 99°. It is slightly higher in infancy and old age than in adolescents and adults. In the same individual also there are certain slight variations in the temperature consistent with health, some of which deserve to be mentioned. In the first place, there are diurnal variations of temperature constantly occurring in healthy persons, which must be kept in mind in reference to the diurnal variations so common in febrile diseases. As a rule, the daily minimum is about daybreak, or between 2 and 8 A. M. After this a rise begins, and continues until late in the afternoon, or to between 4 and 9 P. M. These daily fluctuations are somewhat greater in children than in adults; but in any case they rarely exceed 1° Fahr., and any variation in excess of this is very transient. Secondly, it is well known that muscular exercise increases the heat of the body, while repose tends to its reduction. The differences, however, resulting from this cause, are chiefly observed in the extremities. The temperature, in health, of the hands and feet, is often much below that of the trunk and internal parts. There may be a difference of 20° Fahr. or more between the temperature of the feet and that under the tongue. The effect of exercise is to raise the temperature of the extremities to that of the trunk. It produces little change—not more than an elevation of 1° Fahr. in the temperature of internal parts, as, for example, under the tongue, and even this elevation ceases on the cessation of exertion. Thirdly, the ingestion of food causes a slight rise of temperature. The effect of a full meal is to hasten the normal diurnal rise, or to postpone its fall; but the elevation of temperature resulting from food rarely amounts to 1° Fahr. Fourthly, the temperature of the human body is influenced to the extent of 1° or 2° by that of the surrounding atmosphere. Brown-Séquard found a rise of atmospheric temperature from 46.4° to 85.1° Fahr., to raise the bodily temperature from 97.9° to 100.22° Fahr. When the temperature of the atmosphere exceeds that of the normal standard of the human body, the temperature of the body occasionally exceeds the range compatible with health. It is also to be noted that young children and persons of advanced age have less power than adults of resisting external cold—the temperature of the body being more easily and considerably reduced by it in the former case than in the latter.—*Murchison.*

IMPURITIES OF WATERS.

THERE are certain abnormal conditions of waters, arising from natural or artificial causes, that are not very clearly understood, and which present interesting features for study and investigation. The water of Jamaica Pond, near Boston, affords a somewhat remarkable illustration of such changed condition, or sickness from natural causes, at the present time.

This pond, which is situated at a comparatively high elevation, has one small feeding-stream, and an equally small outlet; it receives no artificial drainage, and is not in a thickly-settled locality. Its water is still supplied, through pipes, to many citizens, and also to the neighboring towns of Brookline and West Roxbury. During the winter of 1866, after two seasons of drought, this water first exhibited the peculiar condition which it presents again this winter, also after two seasons of severe drought.

The water is not perfectly clear, and does not become so by standing; it is cloudy, but not colored; its color and taste are decidedly offensive, resembling water containing putrefying animal matter; these conditions are more evident when the water is heated, and are retained after evaporation to a small volume. Ordinary analysis shows the difference between the common condition of this water and its present peculiar state to be as follows: one United States gallon of each contains—

	NORMAL.	ABNORMAL.
Organic matter.....	1.36 grains.	2.33 grains.
Mineral matter.....	2.41 "	2.56 "
Total weight of impurities	3.77 "	4.89 "

By filtration, through paper, the water becomes clear and brilliant, the odor and taste of the filtered water being natural; and it is possible, in this way, to separate the offensive matter from the water and retain it for examination. This substance, which gives odor, taste, and additional weight to

the impurities, consists of organized and vegetating bodies, which, as seen with the lens, are short, white threads, somewhat like conferva in form, but the threads are very short and perfectly white, differing in these respects from the green or brown confervoid growth of the summer months.

The water of this pond at present exhibits the natural balance between the animal and vegetable life below the surface, disturbed or destroyed. Crustaceous animalculæ, common in the water usually, are not to be found, while there is an extraordinary growth of subaqueous vegetation, of a low order of organized forms, emitting a repulsive odor.

The cause of this change in a large body of potable water, hitherto one of the purest, may be found in the excessive and protracted droughts of the two past seasons, modifying the growth of subaqueous vegetation, and allowing an offensive kind to predominate. And the water will, undoubtedly, recover its normal condition, with the change of seasons and an increased flow from the deep springs affording supplies to the pond, as it did in the spring of 1866 after the former disturbance.

An instance of peculiar condition, caused by artificial means, is that of the water in a manufacturer's well, yielding an abundant supply, but situated about three hundred feet below a brewery, on a hill-side. In this case, after the brewery had been in operation for two years, this well-water, quite unexpectedly, developed a fungous growth of enormous size and quantity. I took from the water in the well several individual plants, which were found floating on the surface, that were each literally nearly as large as a man's head, and, in the month of August, they increased so rapidly as to close the large iron outlet pipe, having a diameter of six inches.

These fungi, when placed in a dilute alcoholic solution, in a warm room, increased in size, producing acetic acid rapidly, and were true vinegar-plants (mother); they evolved a very offensive odor when decaying, and soon rendered the well-water unfit for use. The source of the germs of these plants was traced directly to that part of the brewery where returned empty ale barrels were washed and steamed before being refilled, and where the drainage was not perfect, although the entire floor was paved with bricks laid in mortar. My attention has been called to many other cases of a similar nature, but to none where the cause and effect were so marked as in this well, the water being naturally calcareous, hard, and free from organic matter.—S. Dana Hayes, in *American Chemist.*

A MARKED MAN.

A man has lately turned up in Europe, whose attainments, both lingual and dermal, are exciting no small amount of wonder. Linguistically considered, he perhaps has numerous equals, though it is said that, besides Greek, his native tongue, he speaks Arabic and Persian fluently, French, Spanish, Italian, German, and English, with various degrees of ease and accuracy. But his other attractions are truly extraordinary, though chiefly for their showy superficiality; in which respect, after all, he doesn't differ so very much from a good many other famous people. The man is tattooed from head to foot, there not being a square inch of skin on the whole surface of his body that is not covered with tattoo-marks. His story is, that tattooing was inflicted on himself and two others in Chinese Tartary, as a punishment for acts against the government; that one of his companions died; the other was made blind, and is now living in Hong-Kong, while he had succeeded in making his escape. The man has a fine physique, and, stripped, appears as if his whole body were closely enveloped in a richly-woven web of Turkish stuff. Closer inspection, however, resolves this appearance into a great variety of figures, mostly of plants and animals, that have been pricked into the skin in colors of blue and red. Altogether there are some 384 such figures, representing apes, leopards, cats, tigers, eagles, storks, swans, men, women, elephants, lions, crocodiles, snakes, fish, snails, fruit, leaves, flowers, etc., while on the hands are certain inscriptions, said by Prof. Müller to belong to the language of Burmah. The marking appears to have been done with the juices of plants, as there are no traces of enlarged lymphatics, such as are often produced when tattooing is

done with pulverized charcoal, or gunpowder. Then the instrument with which this man was tattooed, and which he brought away with him, is split like a steel pen at the tip, so that fluid substances could easily be taken up by it.

CONSANGUINEOUS MARRIAGES AND IDIOCY.

Dr. Mitchell, of the Edinburgh College of Physicians, says of idiocy and its relations to marriages of consanguinity, that in more than sixty per cent. of the cases of idiocy occurring in the British Isles the condition is acquired, not congenital, and is due to one or other of the numerous accidents to which children are liable. He disapproves of unions of near relations, but states that proof is wanting that any evil resulting from them is dependent on a mysterious influence intrinsic in the consanguinity itself. His objections to marriages of blood-relations proceed rather from a consideration of the increased risk in such unions of the transmission of morbid peculiarities. Thus, if a deaf-mute is married to a person in possession of the faculties of speech and hearing, the chances of having a deaf-mute child will be as 1 to 135; but, if deaf-mutes intermarry, the chances of having a deaf-mute child rise to 1 in 20.

Speaking of the causes which produce idiocy after birth, Dr. Mitchell points out that purely intellectual exercise, in excess, is more detrimental to children than purely emotional exercise in excess, but the reverse holds true in the case of adults. In children as well as in grown-up persons, disorder of the moral faculty, as a rule, precedes intellectual disorder, and overteaching of pupils is first apparent in change of character. Prolific causes of idiocy are scarlet fever, whooping-cough, and measles, diseases to which thirty per cent. of all the idiots and imbeciles in Great Britain are due.

TESTS OF IMPURE WATER.

In its provisions for securing to consumers a sufficient supply of pure water, the public health bill, now before the English Parliament, thus defines what will be considered as polluting liquids:

1. Any liquid containing in suspension more than three parts by weight of dry mineral matter, or one part by weight of dry organic matter, in 100,000 parts by weight of the liquid.

2. Any liquid containing in solution more than two parts by weight of organic carbon, 1, or .03 by weight of organic nitrogen, in 100,000 parts by weight of the liquid.

3. Any liquid which exhibits by daylight a distinct color, when a stratum of it 1 inch deep is placed in a white porcelain or earthenware vessel.

4. Any liquid which contains a solution, in 100,000 parts by weight, more than two parts by weight of any metal except calcium, magnesium, potassium, and sodium.

5. Any liquid which, in 100,000 parts by weight, contains, whether in solution or suspension, in chemical combination or otherwise, more than .05 part by weight of metallic arsenic.

6. Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than one part by weight of free chlorine.

7. Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

8. Any liquid possessing an acidity greater than that which is produced by adding two parts by weight of real muriatic acid to 1,000 parts by weight of distilled water; or—

9. Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1,000 parts by weight of distilled water.

PERMANENT PHOTOGRAPHS.

The difficulty with photographs is, that they fade; the *desideratum* is to give them stability. Mr. W. H. Sherman, of Milwaukee, has been experimenting for some time past with a view to this object, and claims to have reached the result sought. His object was to introduce an unchangeable pigment of some kind into the print by deposition from solution, and he succeeds with the bisulphide of mercury (vermilion). The process and its explanation are as follows: "A solution is prepared, composed

of hyposulphite of soda and a mercurial compound in such proportions that the bisulphide of mercury is slowly deposited, the deposition being almost entirely suspended until the print containing the unreduced chloride of silver is added to the solution. The withdrawal of hyposulphite to dissolve the chloride causes the deposition of the bisulphide to take place in the print." Pictures obtained in this manner resist strong reagents in a way that gives promise of great permanence, while they have a rich tone, and a novel and fine effect. Mr. Sherman has been experimenting a good deal on the precipitation of vermilion, and finds the color of the product powerfully affected by light.

THE SUN'S ATMOSPHERE.

Dr. Janssen, the French astronomer, in a letter to Prof. Newton, of Yale College, an extract from which is published in the *American Journal of Science and Arts*, says of the sun's atmosphere: "My observations prove that, independently of the cosmical matter which should be found near the sun, there exists about the body an atmosphere of great extent, exceedingly rare, and with a hydrogen base. This atmosphere, which doubtless forms the last gaseous envelope of the sun, is fed from the matter of the protuberances which is shot up with great violence from the interior of the photosphere. But it is distinguished from the chromosphere and the protuberances by a much smaller density, a lower temperature, and perhaps by the presence of certain different gases." Janssen proposes to call this the "coronal atmosphere," as he considers it to produce a large portion of the phenomena of the solar corona.

SCIENTIFIC ADVANCE IN GERMANY.

Prof. Virchow, in his address before the Congress of German Naturalists, states some facts which show what progress freedom of discussion has made in Germany since the beginning of the present century. "Not perhaps at the dead of night, but still beneath the veil of secrecy, a handful of *savants* assembled for the first time at Leipsic, at the invitation of Oken. In fact, in 1822, no considerable body of men could come together in Germany, in answer to a public invitation, with the permission of the civil authority. They could not discuss among themselves scientific questions, no matter how unconnected with the political and national questions of the day. Add to this that other fact, that, if I am not mistaken, it was only in 1861, at the Congress of Naturalists at Spires, that the names of the Austrian members could be made public, and then we can appreciate the tremendous change that has been brought about in Vaterland." In the same address Dr. Virchow pays a well-earned tribute of honor to French *savants*. He opposes also the suggestion that has been made by certain German professors, that *brevets*, or honorary memberships of French Academies, etc., held by German scientific men, should be sent back, for the reason that a distinguished French botanist had recently declined the honor of being made an associate of the Natural Science Academy of Leipsic.

ACTION OF SEWAGE-GAS ON LEAD PIPES.

Dr. Andrew Fergus states that lead soil-pipes are often found corroded and even perforated in positions which justify the belief that the destructive agent is sewer-gas. The corroding action always takes place from within, and is generally confined to the upper surface of the pipe most frequently in those situations where it lies in an horizontal position, though vertical pipes and the upper surfaces of bends are sometimes affected. Among the diseases he has observed as resulting from this state of things, typhoid fever, diphtheria, scarlet fever, and diarrhœa, are mentioned.

COOLING AND VENTILATION OF RAILWAY-CARRIAGES.

An ingenious contrivance for excluding dust and cooling the air of railway-carriages in hot countries is described in a late number of *Engineering*. It consists of an arrangement attached to the under side of the carriage, into which air is admitted and made to pass between layers of material that are kept constantly wet by a supply of water from above, and that present a large evaporating surface. By this means all dust is arrested in the chamber, and the air

cooled before it enters the interior of the carriage. The windows of the car are so arranged that thorough ventilation is secured and the accumulation of moisture prevented. The appliance is now in use on several railways in India, and is found to be of great value. The average reduction of temperature secured by it is about 15° Fahr., with an evaporation of six gallons of water per hour. With a larger amount of water it is said that a reduction of 30° may be readily obtained.

CONSCIOUSNESS AFTER DECAPITATION.

M. HEINDRICH, who filled the office of headsman in Paris for fifty-four years, has lately died, after officially cutting off the heads of 139 criminals. He appears to have been a man of some cultivation; and had sufficient interest in his business, it is said, to attend the lectures of Velpeau, in order to obtain a knowledge of the exact position of the "vital joint." He also made various improvements in the construction of the guillotine. A visitor once asked him if he thought the separated head retained consciousness after it had fallen into the basket. Without giving a direct reply, he related several instances which went to support an affirmative answer. On one occasion he said a woman's head made a faint effort to spit at him; and he also spoke of violent contortions occurring in the muscles of Orsini's face — a phenomenon that has been observed in the faces of others immediately after decapitation. It is the opinion of the *Lancet* that these movements are reflex, and not at all of a conscious nature. They are probably due to the sudden loss of a large amount of blood, which here, as elsewhere, gives rise to convulsions. The mere blow must stun, and, before recovery takes place, the flow of blood from so many large vessels would be sufficient to produce perfect unconsciousness.

FOSSIL FLOWERS AND INSECTS.

A FAUNA and flora of the Eocene period have been dug out of the rocks by M. Munier-Chalmar, of the French Geological Society. He exhibited before it crustacea, insects, and flowers, in a wonderful state of preservation. The minutest details of the delicate organization of these vegetable and animal species are preserved with great nicety and fidelity. The flowers retain their calix and corolla, and some of the stamens still have their anthers. M. Munier exhibits some which are yet buds, others just blown, and still others with their petals all gone, and nothing left but the ovary. We may still observe the soft appearance of the insect larvæ, and can even discern the nerves of the budding wings of the nymphæ. Among the insects M. Munier recognizes a familiar domestic bug, in which may be seen the glands which secrete the mal-odorous liquid peculiar to those insects. Finally, among the crustacea, he has found a new species, in which we may study the minutest details of the masticatory apparatus.

A PHOSPHORUS-LAMP.

THE following is a description of a safety-lamp, employed by the watchmen of Paris, in all magazines where explosive material is stored: An oblong phial of the whitest and clearest glass, containing a piece of phosphorus about the size of a pea. Pour in some olive-oil, heated to the boiling-point, until the phial is two-thirds full, and then seal it up hermetically. To use it, remove the cork, allowing the air to enter the phial, and then recork it. The whole empty space in the bottle will then become luminous, and the light obtained will be equal to that of a feeble lamp. As soon as the light grows weak, its power can be increased by uncorking the phial, and allowing a fresh supply of air to enter. Thus prepared, the phial may be used for six months.

EFFECTS OF TRAINING.

THE *Lancet*, in a short article on "training and its risks," *à propos* of the recent university boat-race, says: "We could mention numerous cases in which the reserve force of the system has been so forestalled by amateur oarsmen that not only specific vascular disease, but physical decrepitude, has declared itself long before the meridian of life. Within the last few days we have seen a list of cases in which, besides premature ill-health, even death itself was induced by the constant practice of rowing, followed by the tremendous final struggle. It is not only that the transition from customary to athletic regimen, and *vice versa*, has evils of

its own, even in the case of professional watermen, but such evils are aggravated for the university amateur, who has so often to proceed from hard rowing to hard reading."

PHYSIOLOGICAL ACTION OF CAFFEINE.

According to Prof. Aubert's estimate, roasted coffee contains only about one-fourth per cent. caffeine; and, if so, it is not easy to account for the exciting effect of the infusion. The action of caffeine upon the spinal cord is analogous to that of strychnine, but far weaker. It notably augments palpitation of the heart. Artificial respiration arrests its mortal effects. Caffeine also produces transitory paralysis of the pneumogastric nerve. Dr. Nasse supposes that the action of the infusion of coffee is to be attributed, not to the caffeine alone, but to empyreumatic matter.

THE DEEPEST WELL.

The Germans claim the deepest hole that has ever yet been bored into the earth. It is situated near a small village about twenty-five miles from Berlin. The boring was commenced in 1867, and stopped last year, at a depth of 4,170 feet. The diameter of the hole at the top is 15½ inches. For the first 284 feet the drill passed through solid gypsum, when a bed of quite pure rock-salt was struck, the under side of which had not been reached when the boring ceased. Careful observations of the temperature at various depths are now being made, which will be placed before the public when completed.

PHYSICAL CONDITION OF CENTENARIANS.

In a paper lately read before the London Anthropological Society on the physical condition of centenarians, Sir Duncan Gibb gives an interesting account of the examination of six persons who had severally reached the age of one hundred years. He found the organs of circulation and respiration in a condition more approaching to the prime of life than old age. None of those changes which usually mark the age of seventy were observed; and, in nearly all, the special senses were unimpaired, and the intelligence perfect, which shows at least the complete integrity of the nervous system.

ARROW-HEADS IN NEW JERSEY.

Dr. Charles G. Abbott, writing in the *American Naturalist* on the "Stone Age in New Jersey," states that stone arrow-points of every variety are found at numerous points throughout the State, and that a reference to the drawings of arrow-points in Nilsson's "Stone Age in Scandanavia," and Lubbock's "Prehistoric Times," shows that whatever they have illustrated, either from the north of Europe or Terra del Fuego, is also to be met with in New Jersey. These arrow-heads are shaped from a great variety of minerals, but those made of various forms of quartz are the most abundant.

HONORS TO PROF. DANA.

At the meeting of the Geological Society of London, for February 16th, the president, Mr. Joseph Prestwich, presented for transmission to Prof. Dana, of New Haven, what is regarded as the highest honor the Society can confer, namely, the Wollaston gold medal, which had previously been voted by the council to this distinguished scientist. Prof. Dana's labors were spoken of in the highest terms; his numerous important contributions to almost every branch of geological science being characterized as remarkable, both for learning and skill of presentation.

COPPER IN ORGANIZED STRUCTURES.

Besides its wide-spread diffusion in the inorganic world, copper is also a frequent constituent of plants and animals. It is almost constantly found in flour, straw, hay, meat, eggs, cheese, and other articles of food, and also in sea-weed. In the animal kingdom, it occurs in the blood of certain mollusks and crustaceans, and is likewise found in the blood and tissues of many of the higher animals—in proportionally large quantity in the liver and kidneys.

M. Duclaux has lately discovered it in cacao-beans. The proportion is greatest in the outer covering or husk, although the inner parts, of which chocolate is made, also contain a notable quantity. Dr. Craig, of the Army Medical Museum, Washington, has quite recently found traces of copper in oysters; not in sufficient amount, however, to account for the green color which they sometimes present.

MAGNETIC VARIATIONS.

THE last word about solar influence is uttered by Carl Hornstein, of Prague, who, summing up the results of an immense number of observations, says that the variations of each of the three elements of terrestrial magnetic force, declination, inclination, and horizontal intensity, have a period of about 26½ days. This periodicity can hardly be explained, except by the influence of the sun.

COLD IN GERMINATION.

THE cold of winter is said by M. Duclaux, of the Paris Academy of Sciences, to be necessary for the germination of certain vegetable grains, and for hatching the eggs of the silk-worm. His researches in this matter he proposes to continue and to extend, so that the effects of cold may be ascertained to the greatest possible degree of exactitude.

NOTES.

A REMARKABLE case of reproduction of the elbow-joint after resection is given by the *British Medical Journal*. The subject was a weakly girl, aged 13, whose elbow had become fixed in a faulty position, after inflammation. On account of this, and of disease of the bone, resection or removal of the joint was performed. The piece of bone removed was one and a third inch long in front, and two and a half inches behind; the articular portions of the bones of both arm and forearm being thus taken away. The child recovered, with power of moving the elbow between the angles of 60 and 113 degrees; rotation, however, was impossible. Two and a half years after the operation, the child died, and, on examination, a new elbow-joint was found, having its articular surfaces covered with cartilage, and provided with a synovial membrane.

THE *Engineer* says that the oxyhydric light has not proved a success in Paris, and it has been discontinued in the public lamps on the Boulevard des Italiens. It is not generally known that a carburating apparatus is always employed in conjunction with oxygen, which adds to the complication of the apparatus as well as the cost of the light. There are but few, remarks *Le Gaz*, who will consent to have installed in their houses two meters, two regulators, a carburator, and two distinct systems of pipes. For this reason alone the system was certain to fail, even if the alleged economy were proved which has never been the case.

A SIMPLE mode of distinguishing with certainty between apparent and real death is given by Dr. Ars-Drouet, of the Paris Academy of Medicine. It consists in fastening a bandage, handkerchief, or cravat, etc., around the forearm, just below the elbow, or around the leg below the knee. If the patient still lives, the subcutaneous veins become inflated, swollen, and bluish under the skin; but, if life is extinct, there will be no change in the appearance of these veins.

FROM a statement made by Dr. Günther, in the January number of the *Magazine of Natural History*, it would appear that the national collection which in the year 1858 contained 480 species of snakes, represented by 3,990 examples, possesses now 920 species, represented by 5,500 examples. The number of typical specimens is 366, the total number of species of snakes known at present being calculated at about 1,100.

THE perfect fossil skeleton of a man has just been discovered in a cavern near Meudon, France, by Dr. Rivière, who sends a communication on the subject to the French Geological Society. The skeleton was in an inclined position, and in the attitude of repose: the legs were partially bent, and the one rested on the other. A necklace made of shells and perforated teeth was found upon it.

EXPERIMENTS with petroleum as a fuel in the puddling-furnace are said to have been attended with great success in France. The experiments were made under many varying conditions, and were conducted by practical and reliable men. It is asserted that, for convenience, efficiency, and, above all, for the superior quality of iron produced, there is nothing that equals petroleum in this manufacture.

IN a paper read before the Iron and Steel Institute of England, Mr. J. Head states that, while there is as much heating-power in a pound of average coal as is necessary to procuce 17 pounds of puddled bar-iron, there are few furnaces where more than one pound of iron is brought out to one pound of coal consumed.

IF a sailing-ship be provided with a screw-propeller, the latter will revolve when the ship makes way; and it is proposed to apply the power thus obtained to operating a magnetic apparatus, which would furnish a far brighter signal-light than any oil-lamp.

THE tannate of quinine has been substituted for the sulphate by Dr. Listach, of Bona, Algeria. Having employed the tannate in numerous cases, he found that it produced neither headache, nor deafness, nor singing in the ears, ordinarily produced by the sulphate. Unlike the latter, also, it possesses no bitter taste, nor does it cause over-excitement in nervous females.

M. SMITH has written a paper, for the French Geological Society, on the carcasses of mammoths found in Siberia, with their flesh and integument preserved. He maintains that these animals were essentially arctic (like the musk-ox), that they found a grave in their native home, and that they were not drifted to Siberia by currents, as some have thought.

A NEW process for water-proofing leather consists in the exhaustion of the air from the pores of the leather, and then filling them up with a substance which unites with and adheres to the fibre, thereby strengthening without impairing the elasticity of the material, while at the same time it is rendered impervious to moisture.

IN 1804, when Sir Humphrey Davy was but twenty-six years old, Dr. Dalton, the famed originator of the atomic theory, consulted him as to the best mode of preparing his lectures, and afterward described him as "a very agreeable and intelligent young man, the principal failing in whose character as a philosopher is that he does not smoke."

To distinguish benzole, which is made of coal-tar, from benzine, which is made from petroleum, Brandberg recommends that a small portion of the substance under examination be poured upon a little piece of pitch in a test-tube, when, if the liquid is benzole, it will immediately dissolve the pitch to a tar-like mass, while benzine will scarcely be colored.

A DISTINGUISHED physiologist makes the assertion that about the heaviest tax on the memory is that imposed by the profession of the pianist. Rubenstein lately played by heart a piece which, according to actual count, contained but ten less than sixty-three thousand notes!

BREAD made with sea-water is recommended for patients suffering from dyspepsia, phthisis, and scrofula. Those who have tried it testify that it is "extremely pleasant" to the taste.

THE use of anæsthetics in veterinary practice is highly spoken of by an experienced veterinary surgeon of London.

AN aching tooth has been extracted from the jaw of a member of the British Odontological Society, the dental canal cleansed, and the decayed portion cut away; and then the tooth was replaced in its socket, as in the case of artificial teeth. In two weeks, it is said, the tooth was serviceable.

M. BARETY, member of the Biological Society of Paris, describes an interesting case of sweating, confined to the right side of the face. The curious phenomenon occurred at the outset of a fatal meningitis (inflammation of membranes covering brain and spinal cord), and lasted an hour.

DURING the last ten years, 2,778 photographs of the sun have been taken at the Kew Observatory. It is now announced that the almost continuous photographic record of the state of the sun's disk thus obtained is soon to be brought to a close.

HALLWACHS has found that both green and red colored carpetings frequently contain arsenic. He asserts that the brilliant dark-red colors, now so popular, contain enormous quantities of this poisonous substance, burning with the blue flame of arsenic, and giving its characteristic garlic odor.

IT has been found that the clothes fitted to new recruits in the English army soon become too small across the chest, and too tight around the neck, owing, it is stated, to the increased development given by gymnastic and military exercises.

LITHOFRACTEUR is rapidly replacing powder as a means of removing obstructing wrecks. Two charges of fifty pounds each recently accomplished on a sunken wreck what would have required tons of gunpowder, and much difficult labor.

IN South America are found earthworms that oftentimes attain a length of 40 inches, and which have a circulatory system of great perfection. They are found to possess hearts composed, like those of the higher animals, of a soft auricle and of a very muscular ventricle.

THE fossil horse is found among the tertiary and quaternary formations in Ecuador, showing that this continent possessed that animal previous to the Spanish settlement, though he became extinct.

AT Chatham, England, there is a man who regularly refuses to have his children vaccinated, and will not pay the fines. The Anti-Vaccination Society support his wife and family while he is in prison.

The Popular Science Monthly has been well received by the press, and the project is cordially commended, as the following extracts will show:

"We think it is not too much to say that this is the best first number of any magazine ever published in America."—*New York World.*

"This is just the publication needed at the present day, when people are beginning to wake up to the importance of knowing something of the grand and beautiful processes of Nature, and of the thousand departments of scientific knowledge, the study of which strengthens and elevates the faculties, and opens up so many new sources of intellectual enjoyment."—*Montreal Gazette.*

"The new journal will meet with a deserved popular success, for the field is an open one, and THE POPULAR SCIENCE MONTHLY is equal to the occasion; it is beyond comparison the best attempt at journalism of the kind ever made in this country."—*Home Journal.*

"The initial number is admirably constituted. It opens fittingly with a paper by Mr. Herbert Spencer which we commend most earnestly to all thoughtful men. With the improvements that will come by experience, we look to see THE POPULAR SCIENCE MONTHLY a periodical of superlative merit, and a thorough success."—*New York Evening Mail.*

"The initial number amply fulfils the promise of its conductors, and, by the vigor and breadth of its discussions, no less than by the interest of the topics chosen, claims the public support and patronage. Scientific discovery in all departments moves forward so rapidly, and opinions, if it must be confessed, shift with such surprising readiness, that there is need of a full and well-conducted periodical to record the changes."—*Boston Journal.*

"THE POPULAR SCIENCE MONTHLY, conducted by Prof. Youmans, and published by the Appletons, is a new-comer in the periodical field, and one for whose success we cannot but wish earnestly. In our opinion, the right idea has been happily hit in the plan of the new monthly. There is a positive need for such a journal as this, and we hope that the large number to whom its appearance must be welcome will see that it is a success from the start."—*Buffalo Courier.*

"This is a highly-auspicious beginning of a useful and much-needed enterprise in the way of publication for which the public owe a special debt of obligation to Messrs. D. Appleton & Co."—*Boston Gazette.*

"A journal which promises to be of eminent value to the cause of popular education in this country. It is to be hoped that an experiment of such unquestionable public utility will meet with support in accordance with its merits."—*New York Tribune.*

"We have not met a new acquaintance in the literary world which we can welcome more heartily than we do this new monthly. It meets a want which has long been felt by the friends of popular learning in our country.—*Lockport (N. Y.) Daily Union.*

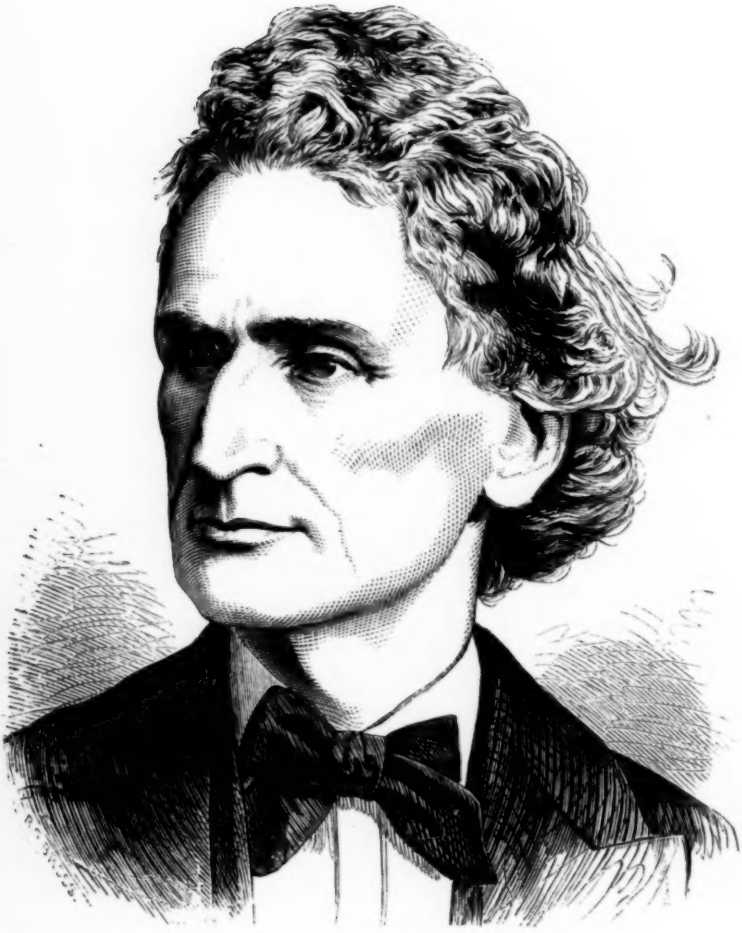
"The articles selected from the leading foreign periodicals are of great value—particularly Mons. A. De Quatrefages's instructive and suggestive lecture on the Natural History of Man. The success of this periodical, so much needed and so well edited, may be taken for granted."—*Philadelphia Press.*

"This new enterprise appeals to all intelligent seekers for truth, all lovers of knowledge, all friends of investigation, and all who are interested in the laudable effort of diffusing that information which is best calculated to expand the mind, and improve the conditions and enhance the worth of life."—*Golden Age.*

"Messrs. D. Appleton & Co. have certainly carried out one of the memorable 'happy thoughts' of these times, in preparing THE POPULAR SCIENCE MONTHLY. It is just what is wanted by the curious and progressive mind of this country, and ought to be widely circulated."—*New York Evening Post.*

"That there is a place for THE POPULAR SCIENCE MONTHLY no one can doubt who has watched the steady increase of interest in scientific investigation manifested in this country, not only by a select class, but by the entire community. The success of a periodical of this nature, if it is rightly conducted, cannot for a moment be doubted, and, in this respect, we would say that, if the managers of this one will only continue as they have begun, they may be assured of a circulation at once large and appreciative. Prof. E. L. Youmans, who is the editor, has made arrangements with the leading scientific periodicals of Europe, so that he can publish papers of special interest from their advance-sheets among his selected articles."—*New York Times.*

"This new magazine, in our estimation, has more merit than the whole brood which have preceded it."—*Oswego Press.*



JAMES DWIGHT DANA.